EOSDIS CORE SYSTEM (ECS)
REQUIREMENTS ANALYSIS REPORT

(Deliverable 0502)

July 14, 1995

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1. EXECUTIVE SUMMARY

This technical analysis report (TAR) documents the results of an independent ECS requirements analysis conducted by the EOSDIS IV&V team over the period 18 April 1995 to 14 July 1995. This report is an update to the IV&V "ECS Preliminary Requirements Analysis Report" submitted in October 1994. The objective is to assess the technical integrity (i.e., traceability, quality, and testability attributes) of the ECS Functional and Performance Requirements Specification (F&PRS) contained in the 2 June 1994 (through CH-07, dated 15 February 1995) baseline. Traceability is also assessed for ECS Level 2 requirements contained in the ESDIS Project Level 2 Requirements, Volume 1 (through CH-21, dated 15 February 1995). The analysis identifies, characterizes, quantifies, and recommends solutions to problems with: 1) the baseline requirements, 2) missing or incomplete requirements, 3) parent-child linkages, and 4) the configuration management of requirements and linkages.

Discussion of Findings

Identified issues are quantified into three levels of severity - major, moderate, and minor. Exhibit 1-1 summarizes the number of requirements exhibiting problems, by level of severity, including a count of those with no identified problems. As shown in the exhibit, Level 2 requirements are grouped according to the major sections of the Level 2, Volume 1 ECS requirements document; Level 3 requirements are grouped by segment as indicated in the ECS Level 3 F&PRS.

Level 2 Volume 1	Total No	Major Problems			Moderate Problems			Minor Problems			No Problems		
Requirements	of Rqts	Trace	Qual	Test	Trace	Qual	Test	Trace	Qual	Test	Trace	Qual	Test
Vol 1 S-3.1.1 Gen'l/etc	69	10	n/a	n/a	2	n/a	n/a	26	n/a	n/a	31	n/a	n/a
Vol 1 S-3.1.2 Func/etc.	182	40	n/a	n/a	12	n/a	n/a	20	n/a	n/a	110	n/a	n/a
Vol 1 S-3.2 Evolve/etc.	16	4	n/a	n/a	1	n/a	n/a	3	n/a	n/a	8	n/a	n/a
Level 2 Vol 1 Total	267	54	n/a	n/a	15	n/a	n/a	49	n/a	n/a	149	n/a	n/a
Level 3 ECS	**Total No**	**Major Problems**			**Moderate Problems**			**Minor Problems**			**No Problems**		
Requirements	**of Rqts**	**Trace**	**Qual**	**Test**	**Trace**	**Qual**	**Test**	**Trace**	**Qual**	**Test**	**Trace**	**Qual**	**Test**
ECS EOSD (Sys Lvl)	127	2	0	0	6	1	0	20	23	0	99	103	127
ECS SDPS SDPS	29	6	0	0	1	0	0	4	4	0	18	25	29
ECS SDPS DADS	196	3	0	0	7	8	1	28	27	5	158	161	190
ECS SDPS IMS	189	6	0	0	4	3	0	26	11	1	153	175	188
ECS SDPS PGS	104	4	1	0	2	2	1	13	17	4	85	84	99
ECS FOS FOS	6	0	0	0	1	0	0	0	1	1	5	5	5
ECS FOS EOC	176	1	0	0	1	8	8	26	3	1	148	165	167
ECS FOS ICC	181	0	0	0	3	5	5	4	4	0	174	172	176
ECS CSMS ESN	66	2	0	0	1	0	0	11	2	0	52	64	66
ECS CSMS SMC	145	7	0	0	8	8	0	53	4	0	77	133	145
Level 3 ECS Total	1219	31	1	0	34	35	15	185	96	12	969	1087	1192
n/a: Not Analyzed (Out of scope of this analysis)													
Note: Row values may not sum to total number of requirements since a requirement can exhibit multiple problem levels													

EXHIBIT 1-1: Summary of Identified Requirements Issues

According to our assessment criteria (described in Appendix A), the absence of any traces or the incorrect specification of all traces qualify as major traceability issues. A requirement is assigned

a moderate traceability issue if one or more specified links are clearly missing or clearly inappropriate. Most requirements with minor traceability issues fall into one of two categories: 1) they have weak traces (i.e., traces that are remotely related) that should be omitted, or 2) their trace could be strengthened by the addition of one or more traces.

As compared to our previous analysis submitted in October, 1994, significant differences pertaining to traceability have been identified. This is primarily due to updated traceability information and Level 2 and Level 3 requirements documents, as well as inconsistencies between them. Quality and testability results have shown fewer changes since the previous report, primarily because the requirements themselves show little change. Our analysis yielded several key traceability analysis findings:

- For the Level 2 traceability analysis, which includes assessment of traces to both Level 1 and Level 3 requirements, our results show a decrease in the number of major and moderate traceability issues, and an increase in minor issues, as compared to our previous report.

- A total of 54 major Level 2 requirements problems are identified; 50 are due to no links to Level 1 specified; 2 are due to no links to Level 3 specified; 1 is due to an incorrect trace to Level 1; and 1 is attributed to a requirement that appeared twice (with different text) in the Level 2 Volume 1 requirements specification.

- Level 3 traceability analysis results show a large increase in the number of traceability issues in all categories.

- Most of the Level 3 major traceability issues are attributed to requirements not having any links specified. A total of 31 major Level 3 to Level 2 traceability problems are identified; 20 Level 3 requirements have no traces to Level 2 identified; 8 are attributed to incorrect traces specified; and 3 are Level 3 requirements that should be deleted (including their traces) pending approval of the CCR which proposes changing quick-look data to expedited data. Note: these 3 requirements are flagged as severe because they are not specified for deletion in the CCR.

- The majority of moderate traceability issues are attributed to one or more incorrect links given for each requirement. Most of the minor issues are the result of weak links or the omission of links which could strengthen the linkage. Issues pertaining to inconsistencies between the trace reports and the requirements documents (e.g., trace reports are not current with F&PRS and/or Level 2, Volume 1 specification; traces are given to requirements that have been deleted by baseline changes) are classified as moderate or minor issues.

Discussion of Recommendations

We believe the following recommendations would be of high value to the ESDIS Project and to the success of the EOSDIS:

1. Several problems are symptoms of the trace reports not being current and consistent with baseline changes to the F&PRS and the Level 2, Volume 1 requirements specification. It is imperative that traceability between requirements at all levels be integrated into a single RTM database under ESDIS Project configuration and control. Without this, the technical integrity of the requirements and their traces continues to be at risk.

2. Several Level 3 requirements are cited as ambiguous, broad in scope, or specify compound functionality. As these requirements have the potential for various interpretations, they need to be watched closely to ensure the Level 4 requirements specify the functionality intended, which may not have been clearly presented at Level 3. Furthermore, requirements that specify compound functionality impact testing activities such that if one small portion of a compound requirement fails a test, then the entire test fails.

3. Identify linkages for requirements having none. The IV&V analysis suggests possible linkages for most requirements in this category. If adequate linkages cannot be found, the requirements should either be deleted or new requirements added. If not resolved, there is a potential for intended functionality to be lost and not implemented.

4. The Level 3 requirement traceability reports analyzed do not include peer links. We recommend that peer links be identified and reviewed to ensure proper tracking of the data flows across the various ECS components (i.e., ECS internal interfaces). In the absence of these links, there is a potential danger for breaks in the required data flows.

5. The Level 2 Volume 1 (through CH-21) baseline document needs to be updated to correct errors identified in this analysis. There are requirements that appear twice, and others that appear to have been excluded. The index in the back of the document needs to be updated to reference correct page numbers.

Implementation of the recommendations listed above would help provide a complete, current, consistent picture of the overall technical integrity of the EOSDIS requirements.

2. INTRODUCTION

This section of the EOSDIS IV&V "EOSDIS Core System (ECS) Requirements Analysis Report" presents the purpose, objectives, and scope of the requirements analysis, and includes relevant background information.

2.1 Purpose of the Report

The purpose of this technical analysis report (TAR) is to document the results of an independent ECS requirements analysis conducted by the EOSDIS IV&V team during the period from 18 April 1995 through 14 July 1995. This TAR is an update to the IV&V "ECS Preliminary Requirements Analysis Report" delivered in October, 1994. The purpose of this report is to reassess the findings of the preliminary ECS requirements analysis, based on requirements changes and updated traceability information. Existing and potential problem areas, including their relative severity and possible adverse implications for the ECS development, overall EOSDIS validation/certification, and user satisfaction are presented.

2.2 Objective of the Analysis

The objective of this requirements analysis is to assess the technical integrity (i.e., the traceability, quality, and testability attributes - which are further discussed in Section 3.1) of the ECS Functional and Performance Requirements Specification (F&PRS) contained in the 15 February 1995 baseline (i.e., through CH-07). The analysis identifies, characterizes, quantifies, and recommends (where feasible) solutions to problems with the baseline requirements, the traces from the Level 3, to Level 2, to Level 1 requirements, and the configuration management of requirements and linkages. Potential problems not inherently visible at the individual requirements level are also examined. The analysis further assesses possible impacts of identified and potential problems on the ability to successfully design, implement, and certify the overall EOSDIS, from both a system engineering and user satisfaction perspective.

2.3 Scope of the Analysis

ECS associated requirements are analyzed for traceability across levels 3, 2, and 1 (with the exception of peer links). Quality and testability are analyzed for Level 3 requirements only. EOS Data and Operations System (EDOS) and EOS Communications System (Ecom), and other Project requirements are outside the scope of this analysis. Assessments pertaining to the requirements allocation to releases, requirements criticality assignments, and associated risks are not the subject of this report. These areas will be addressed in subsequent analyses targeted at specific system releases.

2.4 Background Information

This analysis has been performed as part of EOSDIS IV&V Task 5 (Requirements Analysis and Traceability); more specifically, Subtask 5.5 (ECS Requirements Evaluation).

3. METHODOLOGY AND APPROACH

This section describes the IV&V methodology and the technical approach used to perform this requirements analysis. Appendix A describes the overall IV&V requirements analysis methodology.

3.1 Analysis Tasks Performed

Exhibit 3-1 is adapted from the EOSDIS IV&V Independent System Verification and Validation Plan (ISVVP) [2] and illustrates the total potential scope of EOSDIS IV&V requirements analyses. A column titled Level 3.5, also referred to as requirements by release (RBR), has been added to accommodate the release-specific analyses. The requirements analysis activities performed for this effort are indicated by the ✓ symbol. The methodology used to assess requirements traceability, quality and testability is described in Appendix A.

	Level 1	Level 2	Level 3	Level 3.5	Level 4
Traceability	N/A				
ECS		Yes ✓	Yes ✓	Yes	Yes
EDOS		Yes	Yes	Yes	Yes
Ecom		No	No	No	No*
Quality	No				
ECS		Yes	Yes ✓	Yes	Yes**
EDOS		Yes	Yes	Yes	Yes**
Ecom		No	No	No	No
Testability	No				
ECS		Yes	Yes ✓	Yes	Yes
EDOS		Yes	Yes	Yes	Yes
Ecom		No	No	No	No

EXHIBIT 3-1: Requirements Analysis Scope

Yes = If authorized by task assignments and assuming adequate resources available

* traceability linkages for Ecom are accepted, without analysis, from the Ecom IV&V contractor

** If resources or tasking for full Level 4 requirements analysis are not available, Level 4 requirements will only be analyzed to determine if ambiguities found at Level 3 have been satisfactorily resolved.

3.1.1 Traceability Evaluation

Two traceability analyses were performed for the ESDIS Level 2 Volume 1 EOSDIS Core System Requirements [4]: Level 2 to Level 1, and Level 2 to Level 3. The traceability analysis for ECS Level 3 F&PRS [3] requirements was limited to traces to Level 2 requirements. Peer linkages across Level 3 requirements were not established prior to this analysis, and therefore are not included in this evaluation.

3.1.2 Quality Evaluation

ECS Level 3 requirements are evaluated for quality. Level 3 quality issues identified during the preliminary requirements analysis (see ECS Preliminary Requirements Analysis Report [1]) are reassessed. Quality is measured by evaluating each requirement against the evaluation criteria described in Appendix A to determine if the requirement is accurate, unambiguous, complete, flexible, and consistent.

3.1.3 Testability Evaluation

ECS Level 3 requirements are evaluated for testability. Level 3 testability issues identified during the preliminary requirements analysis (see ECS Preliminary Requirements Analysis Report [1]) are reassessed. Testability is rated by evaluating each requirement against the criteria described in Appendix A.

3.2 Constraints Affecting the Analysis

Baseline requirements traces between levels 2 and 1 were obtained from one source, whereas baseline traces between levels 2 and 3 were obtained from a second source. The Level 2/1 traces are currently maintained in RTM, however the Level 3/2 traces are maintained in another automated tool. The lack of a single integrated database introduces the potential for inconsistencies between requirements that are being analyzed (i.e., the traces are based on different versions of common requirements documents).

The Level 3/2 requirements traces did not reflect the most recent versions of the Level 2 and Level 3 requirements documents that were available when our analysis began. We did, however base our analysis on the current requirements documents by examining the given traces (by requirements identifiers) using the requirements text provided in the updated requirements documents.

The definition of Level 2/1 and Level 3/2 requirements traces are still evolving. During the course of our analysis, we obtained updated traceability information for both Level 2/1 and Level 3/2 traces, which were subsequently incorporated into our findings. The process of determining changes, however, remains a manual and cumbersome process. This limitation can be mitigated by using RTM's database partitioning tool once requirements and traces across all levels are integrated into a single RTM database.

3.3 Problem Classification

Traceability, quality, and testability problems found during the ECS requirements analysis are grouped into the categories shown in Exhibit 3-2. The problems listed under the Quality and/or Testability heading may result in a quality issue, a testability issue, or both.

Problem	Description
Traceability	
No Valid Trace Specified	All higher-level or lower-level traces specified for the requirement are incorrect, or no traces have been specified at all.
Questionable Trace	One or more traces specified for the requirement is weak. The requirement's traces could be strengthened by adding another trace(s), or by deleting a specified trace that appears inappropriate.
Quality /Testability	
Inconsistent Level of Detail	The level of detail (i.e., stated terminology or functionality) specified by the requirement is inconsistent with that of another requirement at the same level, another section of the requirements document (F&PRS), or a standard referenced by the requirement.
Incomplete/Inaccurate Requirement	The requirement may be lacking desired or needed functionality, or the specified functionality may be inaccurate. This may have occurred as the requirement was decomposed from a higher level.
Redundant Requirement	Functionality specified in the requirement appears to be redundant with another requirement at the same level.
Broad Scope/Ambiguous Wording	The wording of the requirement is unclear or very general which could result in more than one interpretation. The scope or purpose of the requirement may be unclear due to missing details.

EXHIBIT 3-2: Requirements Analysis Problem Classifications

4. LEVEL 3 ECS SYSTEM LEVEL REQUIREMENTS

4.1 Discussion of Results

The ECS is comprised of the Flight Operations Segment (FOS), the Science Data Processing Segment (SDPS), and the Communications and System Management Segment (CSMS), which collectively provide the services to command and control spacecraft instruments and to manage the earth science data repository. The ECS system level requirements are those requirements that are common to all three ECS segments, and are prefaced with "EOSD". There are a total of 127 ECS system level requirements.

Exhibit 4-1 shows the number of traceability, quality, and testability issues found. Issues are grouped according to major, moderate, and minor depending on their severity. Additional detail is presented in the following sections.

	Rqmts	Major			Moderate			Minor			No Problems		
	Total	Trace	Qual	Test	Trace	Qual	Test	Trace	Qual	Test	Trace	Qual	Test
EOSD	127	2	0	0	6	1	0	20	23	0	99	103	127

EXHIBIT 4-1: ECS System Level Requirements Analysis Results

4.2 Identified Problems

Exhibit 4-2 summarizes the traceability, quality, and testability issues found. Issues are categorized by problem classifications described in Section 3.3. Detailed descriptions and recommendations for each of these requirements are in Appendix D. A summary of traceability issues is presented in Appendix C.

Traceability issues

A list of the requirements with traceability problems is given in the Exhibit 4-2. The traceability issues have been classified into two categories: requirements with no valid traces specified and those with questionable traces. Specific traceability issues found are described below.

No Valid Trace Specified

In this case, all Level 2 traces specified for the requirement are incorrect, or no traces have been specified at all resulting in an orphan Level 3 requirement. There are 2 orphan Level 3 requirements identified in the EOSD requirements analysis. Recommendations are given for linking these requirements to the Level 2 requirements.

Problem	Description	Associated requirements
Traceability		
No Valid Trace Specified	All higher-level or lower-level traces specified for the requirement are incorrect, or no traces have been specified at all.	EOSD1085, EOSD2555
Questionable Trace	One or more traces specified for the requirement is weak. The requirement's traces could be strengthened by adding another trace(s), or by deleting a specified trace that appears inappropriate.	EOSD0015, EOSD0030, EOSD0700, EOSD0760, EOSD1030, EOSD1680, EOSD1690, EOSD1605, EOSD1607, EOSD1608, EOSD1740, EOSD1750, EOSD1760, EOSD1770, EOSD2430, EOSD2440, EOSD2550, EOSD2640, EOSD2650, EOSD3820, EOSD4036, EOSD4100, EOSD5110, EOSD5200, EOSD5210, EOSD5230
Quality /Testability		
Incomplete / Inaccurate Requirement	The requirement may be lacking desired or needed functionality, or the specified functionality may be inaccurate. This may have occurred as the requirement was decomposed from a higher level.	EOSD0540, EOSD0545, EOSD0740, EOSD0750, EOSD0760, EOSD0800, EOSD1500, EOSD1750, EOSD2200, EOSD2480, EOSD2550, EOSD3510, EOSD5400, EOSD5410
Broad Scope/ Ambiguous Wording	The wording of the requirement is unclear or very general which could result in more than one interpretation. The scope or purpose of the requirement may be unclear due to missing details.	EOSD0540, EOSD0545, EOSD0740, EOSD0750, EOSD0760, EOSD0800, EOSD1500, EOSD1750, EOSD2480, EOSD2550

EXHIBIT 4-2: Summary of EOSD Level 3 Requirements Issues

Questionable Trace

In this case, one or more traces specified for the requirement is weak. The requirement's traces could be strengthened by adding another trace(s), or by deleting a specified trace that appears inappropriate. A large number of traceability issues (i.e., 26) are in this category due to excessive weak traces and missing links. Recommended trace additions/deletions are given in Appendix C.

Quality and Testability issues

Two types of quality issues identified are Incomplete/Inaccurate Requirement and Broad Scope/Ambiguous Wording. These are briefly described below.

Incomplete/Inaccurate Requirement

The requirement may be lacking desired or needed functionality, or the specified functionality may be inaccurate. Some of the issues identified (i.e., EOSD1030, EOSD1502) are due to references to "quick-look data". Quick-look functionality has been removed from ECS, therefore these requirements are inaccurate. This reference should be changed to "expedited data" in EOSD1502

based on proposed changes in CCR 505-01-41-075. Approval of the CCR is expected to resolve this issue. EOSD1030 was not identified in the CCR and should be modified accordingly. There are also issues identified dealing with the requirements for operational availability and Mean Down Time of certain functions. Some of these requirements (i.e., EOSD3920, EOSD3950, EOSD3960, EOSD3970, EOSD3980, EOSD3990, EOSD4000, EOSD4030) include design goals that could result in Mean Time Between Maintenance (MTBM) values of at least 5 years. Most of the MTBM values derived are 11 years; one requirement (i.e., EOSD3920) had a derived MTBM of 17 years. These values are high and can only be reached with significant cost and development efforts. Our recommendation is to modify the design goal numbers to reflect more realistic MTBM goals. Other requirements lack complete functionality. For example, EOSD2200 discusses applying selection criteria meeting ECS security policies and system requirements when selecting hardware. Software should be included in this requirement since many security requirements are implemented using software. Similarly, software reliability should be included in EOSD3510, which discusses reliability predictions for equipment. Several requirements (i.e., EOSD0740, EOSD0750, EOSD0760, EOSD0800) address test capabilities. It is not clear if these capabilities are distinct from those provided by the EOS Test System (ETS) or in conjunction with the ETS capabilities. It should be made clear which elements/systems are responsible for testing and to what extent.

Broad Scope/Ambiguous Wording

The wording of the requirement is unclear or very general which could result in more than one interpretation. The scope or purpose of the requirement may be unclear due to missing details. EOSD0540 requires that ECS elements be expandable to facilitate updates in data products and algorithms. The word "expandable" makes the scope of the requirement ambiguous. EOSD0545 requires ECS to accommodate "growth", also resulting in broad scope. EOSD2480 states that "unique sessions" are required when security controlled data is being manipulated. It is not clear what is meant by "unique sessions". It could yield several interpretations, thus resulting in a broad scope. EOSD2550 requires that ECS elements "limit" the use of master passwords or use of a single password for large organizations. The word "limit" is also open to interpretation.

4.3 Potential Issues

Potential problems that could arise in subsequent phases of the ECS development life cycle based on our requirements analysis findings are summarized as follows:

- Broad scope of the requirements: Use of the word "Support"

  As described above, a number of requirements have broad scope and/or ambiguous wording which could potentially result in unintended increase in the scope of the system, and in some cases, loss of the intended functionality, as these requirements are decomposed further. The requirements in general use words like "shall provide", "shall accept", "shall generate" etc. providing a precise requirement. However, the F&PRS uses the words "shall support" in many requirements (EOSD0010, EOSD0015, EOSD0630, EOSD0760, EOSD0800, EOSD1705, EOSD2990, EOSD5310, etc.). The intended scope of these requirements is ambiguous.

- Non availability of peer links

  The Level 3 requirement traceability reports do not include peer links. Proper tracking of the data flow within ECS depends on a close scrutiny of the peer links, and in the absence of these links, there is a potential danger of some breaks in the required data flow. Immediate action is recommended to identify the peer links.

5. LEVEL 3 SCIENCE DATA PROCESSING SEGMENT REQUIREMENTS

5.1 Discussion of Results

The Functional and Performance Requirements for the Science Data Processing Segment (SDPS) are divided into the following areas: Segment Level; Data Archive and Distribution System; Information Management System; and Product Generation System. They are prefaced with "SDPS", "DADS", "IMS", and "PGS", respectively. There are a total of 518 SDPS Functional and Performance Requirements; 29 are SDPS segment level, 196 are allocated to DADS, 189 to IMS, and 104 to PGS.

Exhibit 5-1 shows the number of traceability, quality, and testability issues found. Issues are grouped according to major, moderate, and minor depending on their severity. Additional detail is presented in the following sections.

	Rqmts	Major			Moderate			Minor			No Problems		
	Total	Trace	Qual	Test	Trace	Qual	Test	Trace	Qual	Test	Trace	Qual	Test
SDPS	29	6	0	0	1	0	0	4	4	0	18	25	29
PGS	104	4	1	0	2	2	1	13	17	4	85	84	99
DADS	196	3	0	0	7	8	1	28	27	5	158	161	190
IMS	189	6	0	0	4	3	0	26	11	1	153	175	188

EXHIBIT 5-1: SDPS Requirements Analysis Results

5.2 Identified Problems

Exhibit 5-2 summarizes the traceability, quality, and testability issues found. Issues are categorized by problem classifications described in Section 3.3. Detailed descriptions and recommendations for each of these requirements are in Appendix D. A summary of traceability issues is presented in Appendix C.

Problem	Description	Associated requirements
Traceability		
No Valid Trace Specified	All higher-level or lower-level traces specified for the requirement are incorrect, or no traces have been specified at all.	SDPS0040, SDPS0085, SDPS0095, SDPS0115, SDPS0150, SDPS0160, PGS-0430, PGS-0455, PGS-0456, PGS-1250, IMS-0220, IMS-0260, IMS-0705, IMS-0740, IMS-0970, IMS-1430, DADS0700, DADS1640, DADS1950
Questionable Trace	One or more traces specified for the requirement is weak. The requirement's traces could be strengthened by adding another trace(s), or by deleting a specified trace that appears inappropriate.	SDPS0025, SDPS0030, SDPS0100, SDPS0130, SDPS0170, PGS-0290, PGS-0295, PGS-0360, PGS-0370, PGS-0450, PGS-0470, PGS-0480, PGS-0602, PGS-1015, PGS-1080, PGS-1090, PGS-1220, PGS-1230, PGS-1310, PGS-1400, IMS-0050, IMS-0060, IMS-0070, IMS-0090, IMS-0110, IMS-0160, IMS-0190, IMS-0250, IMS-0300, IMS-0460, IMS-0500, IMS-0560, IMS-0575, IMS-0630, IMS-0650, IMS-

Problem	Description	Associated requirements
		0660, IMS-0680, IMS-0700, IMS-0720, IMS-0770, IMS-0780, IMS-0790, IMS-0800, IMS-0950, IMS-0980, IMS-0990, IMS-1080, IMS-1090, IMS-1210, IMS-1220, DADS0110, DADS0120, DADS0140, DADS0145, DADS0170, DADS0175, DADS0180, DADS0190, DADS0260, DADS0320, DADS0570, DADS0610, DADS0890, DADS0901, DADS1020, DADS1160, DADS1350, DADS1375, DADS1390, DADS1510, DADS1520, DADS1550, DADS1610, DADS1805, DADS1960, DADS2060, DADS2230, DADS2315, DADS2440, DADS2460, DADS2950, DADS3010, DADS3040, DADS3055, DADS3090
Quality /Testability		
Inconsistent Level of Detail	The level of detail (i.e., stated terminology or functionality) specified by the requirement is inconsistent with that of another requirement at the same level, another section of the requirements document (F&PRS), or a standard referenced by the requirement	PGS-0150, PGS-0160, PGS-0285, PGS-1030, PGS-1230,PGS-1260, IMS-0910, IMS-1210, DADS0120, DADS0130, DADS0140, DADS0150, DADS0160, DADS0175, DADS0180, DADS1210, DADS1950, DADS1960, DADS1970, DADS2060, DADS2070, DADS2120, DADS2230, DADS2330, DADS2340, DADS2345, DADS2360, DADS2370, DADS2380, DADS2390
Incomplete/ Inaccurate Requirement	The requirement may be lacking desired or needed functionality, or the functionality specified is inaccurate. This may have occurred as the requirement was decomposed from a higher level.	PGS-0295, PGS-0530 PGS-0640, PGS-0960, PGS-1170, IMS-0480, IMS-0590, IMS-0630, IMS-0730, IMS-1000, IMS-1010, IMS-1070, IMS-1470, IMS-1550, IMS-1720, DADS1340, DADS2350, DADS2440, DADS3115
Redundant Requirement	Functionality specified in the requirement appears to be redundant with another requirement at the same level.	PGS-0420
Broad Scope/ Ambiguous Wording	The wording of the requirement is unclear or very general which could result in more than one interpretation. The scope or purpose of the requirement may be unclear due to missing details.	SDPS0120, SDPS0140, SDPS0170, PGS-0140, PGS-0180, PGS-0210, PGS-0380, PGS-0456, PGS-0650, PGS-1150, PGS-1210, IMS-0570, IMS-1060, DADS0430, DADS0610, DADS0680, DADS1640, DADS1700, DADS2170, DADS2470, DADS2480, DADS2910

EXHIBIT 5-2: Summary of SDPS Level 3 Requirements Issues

Traceability Issues

A list of the requirements with the traceability problems is given in Exhibit 5-2. The traceability issues have been classified into two categories: requirements with no valid traces specified and those with questionable traces. Specific traceability issues found are described below.

No Valid Trace Specified

In this case, all Level 2 traces specified for the requirement are incorrect, or no traces have been specified at all resulting in an orphan Level 3 requirement. There are 19 Level 3 requirements identified in this analysis exhibiting this problem. Included in this category are requirements that have Level 2 traces, however the requirement should be deleted based on proposed changes in CCR 505-01-41-075 (i.e., "change quick-look" to "expedited data"), but is not explicitly marked for deletion in the CCR. Therefore, the traces should also be deleted. There are two SDPS related requirements where this issue was found: SDPS0150 and SDPS0160. Approval of CCR 505-01-41-075 is expected to resolve the reported issues. Recommended Level 2 links are given for most of the remaining requirements. However, suitable traces for 2 requirements could not be identified; these requirements are listed in Exhibit 5-3.

Requirement ID	Requirement Text	Remarks
SDPS0115	The SDPS shall accept notification of the possible future availability of out-of-sequence data by the EDOS and shall schedule processing accordingly.	We could not locate any suitable Level 2 trace to this requirement.
IMS-0460	The IMS shall provide the capability to accept metadata problem reports from users, and inform the PGS quality assurance staff of the problem.	The currently indicated traces to the Level 2 requirements 1287 and 586 give for the access of data. No Level 2 trace could be identified for reception of " problem reports from users". However the Level 1 requirement 8.2.4.3 provides a strong link to this L-3 requirement.

EXHIBIT 5-3: Level 3 Requirements with No Valid Level 2 Traces Identified

Questionable Trace

In this case, one or more traces specified for the requirement is weak. The requirement's traces could be strengthened by adding another trace(s), or by deleting a specified trace that appears inappropriate. A total of 85 traceability issues are in this category due to excessive weak traces and missing links. The analysis recommends candidate links to be deleted/added, and are given in Appendix C.

Quality and Testability Issues

Four types of quality issues identified are Inconsistent Level of Detail, Incomplete/Inaccurate Requirement, Redundant Requirement, and Broad Scope/Ambiguous Wording. These are briefly described below.

Inconsistent Level of Detail

The level of detail (i.e., stated terminology or functionality) specified by the requirement is inconsistent with that of another requirement at the same level, another section of the requirements document (F&PRS), or a standard referenced by the requirement. The issues are primarily due to inconsistent terminology. For example, PGS-0150 shows inconsistent details

regarding receipt of data availability schedules mentioned in F&PRS section 7.1.5.2.1, Table 7.1; details of the toolkit requirements in PGS-1030 are inconsistent with Section 7.5.1.3, (last paragraph); and PGS-1230 refers to "special data sets" which are not defined in the F&PRS. There are several DADS requirements where data flows identified in the Conceptual DADS Concept Diagram (Figure 7-4), the Conceptual DADS Data Flows (Table 7-2), and the requirements, all in the F&PRS, are inconsistent.

Incomplete/Inaccurate Requirement

The requirement may be lacking desired or needed functionality. The issues identified are mainly due to incomplete functionality. For example, PGS-0295 requires notifying IMS of the revised completion time, if the processing is delayed. It is necessary for the PGS to include the reason for the delay also, as this information is to be conveyed to the user by IMS (IMS-1040). Requirement PGS-1170 requires that PGS be provided with the capability to identify the data products awaiting QA that have not been reviewed within the allotted time, however the requirement does not address the actions to be taken by PGS upon receipt of this information. Requirement IMS-0590, addressing the on-line and off-line distribution of information, and traced to the Level 2 requirement 1441, is incomplete due to the omission of "photographic products". Distribution of photographic products is part of the Level 2 requirement; this function is not included anywhere else in the F&PRS, resulting in the loss of this functionality. IMS-1010 indicates that the IMS will receive a processing status message to confirm or reject a processing order; this requirement is not complete unless the information is communicated to the user for processing conflict resolution and further actions envisaged in IMS-1020. DADS1340 indicates that DADS will use tools to analyze system performance; the completeness of this requirement is in question without the detail defining where these tools will come from. It is clear in requirement PGS-0430, for example, that the PGS will provide tools to analyze system performance. The accuracy of requirements DADS2440 and DADS3115 are in question because they both reference quick-look data which is pending a change to "expedited data" as per CCR 505-01-41-075. These two requirements, however, are not explicitly marked for change in the CCR and are therefore flagged as potential accuracy issues.

Redundant Requirement

Functionality specified in the requirement appears to be redundant with another requirement at the same level. PGS-0420 requires PGS to provide tools to analyze system performance where as SMC also provides performance management service (SMC-3305 and SMC-3415).

Broad Scope/Ambiguous Wording

The wording of the requirement is unclear or very general which could result in more than one interpretation. The scope or purpose of the requirement may be unclear due to missing details. Requirement SDPS0120, for example, requires that the ECS shall be capable of operating 24 hours a day, 7 days a week. The use of the phrase "capable of operating" is ambiguous and results in the scope of the requirement being ambiguous. Requirement SDPS0170 requires SDPS to accommodate "growth", resulting in broad scope. Requirement PGS-0456 requires PGS to

notify the FDF, of O/A quality checks "when necessary", resulting in an ambiguous requirement. Requirement PGS-1150 specifies a capability to accept the identification of products that are not to be stored in the DADS, however there is no mention about what happens to the product if it is not stored in DADS. Requirement PGS-1210 states that the PGS shall coordinate disposition of PGS data stored temporarily in the DADS; the scope and extent of these "coordination functions" is ambiguous. Requirement IMS-0570 indicates the provision of an incremental search capability; details such a search capability need to be specified to clearly define the scope of this functionality. The use of the word "support" is ambiguous in requirements DADS0610 and DADS0680; it is unclear what specific role DADS will have regarding the functionality suggested in these requirements (see Section 5.3, below).

5.3 Potential Issues

Potential problems that could arise in subsequent phases of the ECS development life cycle based on our requirements analysis findings are summarized as follows:

- Broad scope of the requirements: Use of words "Support" and "Coordinate"

  As described above, a number of requirements are broad in scope and/or contain ambiguous wording. A potential effect is unintended increase in the scope of the system, and in some cases, loss of the intended functionality, when these requirements are decomposed further. In general, the requirements use words like "shall provide", "shall accept", "shall generate" etc., which define a precise requirement. However, the phrase "shall have the capability to support" was found in many requirements (e.g., SDPS0140, PGS-0910, PGS-1410, DADS0680, IMS-0100, IMS-0135, etc.). The intended distinction between these two styles is not clear, however the later case does introduce ambiguity. Similarly, the use of the phrase "shall coordinate", found in several requirements (e.g., SDPS0016, PGS-0190, PGS-1210 etc.), often results in ambiguous requirements.

- Lack of valid traces to the Level 2 requirements

  As described above in Section 5.2, a large number of traceability issues identified are attributed to Level 3 requirements not having valid traces to Level 2 requirements. As part of this analysis, we identify traces for all of them except SDPS0115 and IMS-0460. Failure to identify/provide suitable Level 2 traces could cause problems in later phases of the development life cycle. Traces to higher level requirements are essential for future integration and test activities where test cases are built to test requirements. Lack of adequate traces from Level 3 to Level 2 requirements could imply that the Level 3 requirement specify added functionality that was not intended, which has the potential for added system development costs.

- Lack of peer links

  Our analysis did not entail examining Level 3 peer links because the Level 3 requirement traceability reports we received did not define such linkages. Proper tracking of the data flow

within SDPS depends on a close scrutiny of the peer links; in the absence of these links, there is a potential danger for breakage in the required data flows. The establishment of peer links is recommended to minimize this risk.

6. LEVEL 3 FLIGHT OPERATIONS SEGMENT REQUIREMENTS

The review of the Functional and Performance Requirement Specifications for the Flight Operations Segment involved analyzing three distinct areas: overall FOS segment requirements, EOS Operation Center (EOC) requirements, and Instrument Control Center (ICC) requirements. The ICC segment also includes requirements for the Instrument Support Terminal (IST) sub-element. Analysis focused on assessment of FOS Level 3 F&PRS and traceability of the FOS Level 3 requirements to ESDIS Level 2 Volume 1 ECS requirements.

6.1 Discussion of Results

The Functional and Performance Requirements for the Flight Operations Segment (FOS) are divided into the following areas: the FOS segment level, the EOC Operations Center, and the Instrument Control Center. They are prefaced with "FOS", "EOC", and "ICC", respectively. There are a total of 363 FOS Functional and Performance Requirements; 6 are FOS segment level, 176 are allocated to EOC, and 181 to ICC.

In general, the majority of the problems centered around traceability of the Level 3 FOS requirements to Level 2 requirements, and Level 3 FOS quality issues. A few testability problems were also found, generally the result of identified quality issues. Exhibit 6-1 shows the number of traceability, quality, and testability issues found. Issues are grouped according to major, moderate, and minor depending on their severity. Additional detail is presented in the following sections.

	Rqmts	Major			Moderate			Minor			No Problems		
	Total	Trace	Qual	Test	Trace	Qual	Test	Trace	Qual	Test	Trace	Qual	Test
FOS	6	0	0	0	1	0	0	0	1	1	5	5	5
EOC	176	1	0	0	1	8	8	26	3	1	148	165	167
ICC	181	0	0	0	3	5	5	4	4	0	174	172	176

EXHIBIT 6-1: FOS Requirements Analysis Results

6.2 Identified Problems

Exhibit 6-2 summarizes the traceability, quality, and testability issues found. Issues are categorized by problem classifications described in Section 3.3. Detailed descriptions and recommendations for each of these requirements are in Appendix D. A summary of traceability issues is presented in Appendix C.

Problem	Description	Associated requirements
Traceability		
No Valid Trace Specified	All higher-level or lower-level traces specified for the requirement are incorrect, or no traces have been specified at all.	EOC-4008
Questionable Trace	One or more traces specified for the requirement is weak. The requirement's traces could be strengthened by adding another trace(s), or by deleting a specified trace that appears inappropriate.	EOC-2180, EOC-2190, EOC-2200, EOC-2250, EOC-2350, EOC-2482, EOC-3080, EOC-3160, EOC-4005, EOC-4060, EOC-4100, EOC-4130, EOC-4160, EOC-5050, EOC-5110, EOC-5200, EOC-6080, EOC-6150, EOC-6195, EOC-7115, EOC-7116, EOC-7125, EOC-7140, EOC-7150, EOC-7160, EOC-8372, EOC-8380, ICC-2010, ICC-2015, ICC-3020, ICC-4090, ICC-4170, ICC-4470, ICC-4830
Quality /Testability		
Inconsistent Level of Detail	The level of detail (i.e., stated terminology or functionality) specified by the requirement is inconsistent with that of another requirement at the same level, another section of the requirements document (F&PRS), or a standard referenced by the requirement	EOC-2020, EOC-3030
Incomplete/ Inaccurate Requirement	The requirement may be lacking desired or needed functionality, or the functionality specified is inaccurate. This may have occurred as the requirement was decomposed from a higher level.	EOC-0030
Broad Scope/ Ambiguous Wording	The wording of the requirement is unclear or very general which could result in more than one interpretation. The scope or purpose of the requirement may be unclear due to missing details.	FOS-0020, EOC-2020, EOC-2045, EOC-3160, EOC-3225, EOC-3226, EOC-4015, EOC-4018, EOC-5105, EOC-5187, EOC-6135, EOC-9110, EOC-5105, EOC-8090, ICC-0070, ICC-2120, ICC-4110, ICC-4480, ICC-4540, ICC-4545, ICC-4775, ICC-6020, ICC-6600

EXHIBIT 6-2: Summary of FOS Level 3 Requirements Issues

Traceability Issues

A list of requirements with traceability problems is given in Exhibit 6-2. The traceability issues have been classified into two categories: requirements with no valid traces specified and those with questionable traces. Specific traceability issues found are described below.

No Valid Trace Specified

In this case, all Level 2 traces specified for the requirement are incorrect, or no traces have been specified at all resulting in an orphan Level 3 requirement. There is only 1 FOS Level 3

requirement identified in this analysis exhibiting this problem. A recommendation was given for linking the Level 3 requirement to a Level 2 requirement.

Questionable Trace

In this case, one or more traces specified for the requirement are weak. The requirements' traces could be strengthened by adding another trace(s), or by deleting a specified trace that appears inappropriate. A total of 34 traceability issues are in this category due to excessive weak traces and missing links. The analysis recommends candidate links to be deleted/added and are detailed in Appendix C. Examples are as follows:

FOS-0030: The Level 2 links provided for the FOS requirement addressing the adaptation of a general purpose scheduling interface for communicating planning and scheduling information are questionable.

EOC-4008: The purpose of the requirement is to transmit commands via Ecom, yet Ecom is not included in the link.

ICC-2010: The requirement to access EOC planning and scheduling information can be given a stronger link to Level 2 requirements addressing accessibility of planning and scheduling information.

ICC-2015: Planning and scheduling requirements that address a specific capability to perform "what-if" functions could be strengthened to Level 2 requirements that address interactive planning tools.

ICC-4090: This requirement includes the capability to detect and report gaps in received telemetry data. The referenced links to Level 2 are incomplete and could be strengthened by adding links to a Level 2 requirement that specifies that telemetry should be processed to determine discontinuities.

Quality and Testability Issues

Three types of quality issues identified for FOS are Inconsistent Level of Detail, Incomplete/Inaccurate Requirement, and Broad Scope/Ambiguous Wording. Examples are presented below. Testability issues are associated with broad scope, since development of acceptance criteria is difficult in this case.

Inconsistent Level of Detail

The level of detail, (i.e., stated terminology or functionality) specified by the requirement is inconsistent with that of another requirement at the same level, another section of the requirements document (F&PRS), or a standard referenced by the requirement. The issues are primarily due to inconsistent terminology for FOS. For example:

EOC-2020: The definition for "Long Term Spacecraft Operations Plan" contained within the FOS section differs from the definition stated in the Level 3 document appendix.

Incomplete/Inaccurate Requirement

EOC-3030: The definition for "Long Term Spacecraft Operations Plan" contained within the FOS section differs from what is stated in the F&PRS Appendices.

Broad Scope/Ambiguous Wording

The requirement may be lacking needed detail and clarity, affecting interpretation of the requirement, and the development of acceptance test criteria. Examples of FOS requirements with problems of this type follow.

Broad Scope:

FOS-0020: It is not clear from the Level 3 requirement if the system is required to provide the full complement of FOS capabilities while in the training mode of operations. The scope of this requirement needs further definition to indicate which functions are needed and thus allocate the proper amount of resources.

EOC-3226: Number of simultaneous TOO activities and late changes to be supported is unclear. Since resources are limited and the potential for resource contention exists, the maximum limit on simultaneous TOO and late changes to be supported should be determined.

EOC-4018: "General validation" guidelines are needed for command generation. The type of validation of real-time instrument command groups could be interpreted in many ways, causing possible misunderstandings.

ICC-0070: This requirement to accommodate software and hardware provided by the Instrument Team is broad and needs a narrower definition and reference to an interface standard.

ICC-2120: Examples are needed to clarify the typical activities that are to be supported (i.e., calibration, etc.).

ICC-4545: Criteria are needed for a capability to recommend instrument reconfigurations. It was not clear from the requirement what action or event would trigger these recommendations.

ICC-6020: Clarification of the capability of ICC to establish its configuration is needed. This requirement was ambiguous and needs additional information to define its scope.

ICC-6600: Clarification of performance criteria for the system to respond within 0.5 seconds is needed. It is not clear from the requirement if the response is associated with obtaining a prompt or executing a certain function. Also the system loading assumed for the response should be clearly stated to prevent assumptions.

Ambiguous Wording:

EOC-5105: The purpose for requiring multiple sets of limits needs to be defined. It is not clear from the requirement what the different limit sets would be used and to what extent.

EOC-8090: Clarification of the capability of EOC to establish its configuration is needed. This requirement is ambiguous and needs additional information to define its scope.

Other Problems

Other problems identified during the analysis include the following:

- F&PRS CH-05 changes are not reflected consistently throughout the Level 3 to Level 2 trace report; some deletions have been applied and some have not. For example, section 6.5.2.3.1, DAR Processing Requirements, have largely been deleted by CH-05, yet the associated Level 3 requirements are still in the trace report. CH-05 deletions have, however, been correctly incorporated in the same section (i.e., Section 6.5.2.3.6, Requirement 638 - Quick Look); the requirements ICC-4500 and ICC-4590 have been removed to reflect this change.

- Some Level 2 requirements have been deleted as a result of approved F&PRS changes, however the associated Level 3 traces have not been deleted accordingly. These requirements (found in ICC only) include ICC-1010, ICC-1020, ICC-1040, ICC-1041, ICC-1042, ICC-1044, ICC-1050, ICC-1060, ICC-1070, ICC-1080, ICC-1082, ICC-1090, ICC-1100, ICC-1105, ICC-1110, ICC-1115, ICC-1140, ICC-1160, ICC-1170, ICC-2055, ICC-4412, ICC-4415, ICC-4435, ICC-7110, ICC-7150, ICC-7170, ICC-7180, ICC-7190, and ICC-7200.

6.3 Potential Issues

Potential problems that could arise in subsequent phases of the ECS development life cycle based on our requirements analysis findings are summarized as follows:

- Incomplete Traces

  Incomplete traces can result in functions not meeting all specified requirements. Maintaining accurate requirements traces can assist the program by providing a means of obtaining additional information about a particular requirement. The user can clarify uncertainties by analyzing the origin of the requirement and associated lower level specifications. In addition, information on how a requirement relates to other similar functions provides a complete system specification that is needed during development and testing activities. A recommendation in this area is to formalize configuration control of traceability information in order to provide a single set of links that can be utilized by all participants during system development. This would be implemented by continuing to perform traceability analysis to add new linkages and refine existing ones.

- Broad Scope

  Requirements that are ambiguous or broad in scope have the potential for errors as they are decomposed to lower level requirements, as they are subject to varying degrees of interpretation. As assumptions are made due to missing details, there is an increased potential for these types of errors to proliferate through the detailed design and development phases. The development of test procedures and/or quantitative acceptance criteria can be problematic due to missing details.

- Ambiguous Requirements

  Ambiguous requirements are most likely to affect system development activities by altering the amount of resources allocated to a certain function. Broad requirements and/or inconsistent terminology can translate into different interpretations by the developers thus creating the possibility of a faulty or incomplete functional implementation. This becomes even more critical in requirements addressing system level or interface functions. Ambiguous system requirements can create gray areas requiring additional use of resources during implementation. The additional resources will be better spent for other system functions. Resolution of ambiguous requirements prevents duplication of effort and unnecessary expenditure of funds. Ambiguous requirements would need monitoring to ensure that the desired functionality is preserved as detailed requirements are generated. Again, the recommendation is to furnish requirement information to the program through tools such as RTM to assist in the understanding and interpretation of requirements by providing a source of additional clarification.

7. LEVEL 3 COMMUNICATION AND SYSTEM MANAGEMENT SEGMENT REQUIREMENTS

7.1 Discussion of Results

The Communications and System Management Segment (CSMS) is comprised of two elements, the EOSDIS Science Network and the System Management Center, which provide the communication and system management capabilities that allow the ECS to operate as an integrated information management system. The Functional and Performance Requirements for these elements are prefaced with "ESN" and "SMC" respectively. There are a total of 211 CSMS Functional and Performance Requirements; 66 are allocated to ESN, 145 are allocated to SMC.

Exhibit 7-1 shows the number of traceability, quality, and testability issues found. Issues are grouped according to major, moderate, and minor depending on their severity. Additional detail is presented in the following sections.

	Rqmts	Major			Moderate			Minor			No Problems		
	Total	Trace	Qual	Test	Trace	Qual	Test	Trace	Qual	Test	Trace	Qual	Test
SMC	145	7	0	0	8	8	0	53	4	0	77	133	145
ESN	66	2	0	0	1	0	0	11	2	0	52	64	66

EXHIBIT 7-1: CSMS Requirements Analysis Results

7.2 Identified Problems

Exhibit 7-2 summarizes the traceability, quality, and testability issues found. Issues are categorized by problem classifications described in Section 3.3. Detailed descriptions and recommendations for each of these requirements are in Appendix D. A summary of traceability issues is presented in Appendix C.

Traceability issues

A list of the requirements with traceability problems is given in Exhibit 7-2. The traceability issues have been classified into two categories: requirements with no valid traces specified and those with questionable traces. Specific traceability issues found are described below.

No Valid Trace Specified

In this case, all Level 2 traces specified for the requirement are incorrect, or no traces have been specified at all resulting in an orphan Level 3 requirement. There are 9 orphan Level 3 requirements identified in this analysis. Recommendations are given for linking these requirements to the Level 2 requirements.

Problem	Description	Associated requirements

Problem	Description	Associated requirements
Traceability		
No Valid Trace Specified	All higher-level or lower-level traces specified for the requirement are incorrect, or no traces have been specified at all.	ESN-0005, ESN-0350, SMC-2200, SMC-2210, SMC-8730, SMC-8750, SMC-8770, SMC-2205, SMC-2215
Questionable Trace	One or more traces specified for the requirement is weak. The requirement's traces could be strengthened by adding another trace(s), or by deleting a specified trace that appears inappropriate.	ESN-0006, ESN-0010, ESN-0240, ESN-0250, ESN-0280, ESN-0600, ESN-0610, ESN-0740, ESN-0810, ESN-0910, ESN-1206, ESN-1207, SMC-1330, SMC-1350, SMC-2100, SMC-2220, SMC-2410, SMC-2420, SMC-2500, SMC-2510, SMC-2600, SMC-3300, SMC-3370, SMC-3380, SMC-4300, SMC-4310, SMC-4311, SMC-4330, SMC-5360, SMC-6300, SMC-6301, SMC-6340, SMC-6360, SMC-6380, SMC-6400, SMC-6410, SMC-6420, SMC-7300, SMC-8300, SMC-8700, SMC-8710, SMC-8790, SMC-8800, SMC-8820, SMC-8840, SMC-8841, SMC-8860, SMC-8880, SMC-8890, SMC-8920, SMC-1305, SMC-1315, SMC-2105, SMC-2405, SMC-2415, SMC-2505, SMC-2605, SMC-3305, SMC-3345, SMC-3385, SMC-4315, SMC-4325, SMC-4335, SMC-6345, SMC-6385, SMC-8305, SMC-8705, SMC-0300, SMC-0310, SMC-0320, SMC-0330, SMC-0340, SMC-0350
Quality /Testability		
Incomplete / Inaccurate Requirement	The requirement may be lacking desired or needed functionality, or the specified functionality may be inaccurate. This may have occurred as the requirement was decomposed from a higher level.	ESN-0210, SMC-1300, SMC-1500, SMC-2400, SMC-2410, SMC-2420, SMC-2430, SMC-2450, SMC-2510, SMC-2520, SMC-8820, SMC-3421
Redundant Requirement	Functionality specified in the requirement appears to be redundant with another requirement at the same level.	ESN-0240
Broad scope/ Ambiguous Wording	The wording of the requirement is unclear or very general which could result in more than one interpretation. The scope or purpose of the requirement may be unclear due to missing details.	ESN-0240, SMC-1300, SMC-1500, SMC-2400, SMC-2410, SMC-2420, SMC-2430, SMC-2450, SMC-2510, SMC-2520

EXHIBIT 7-2: Summary of CSMS Level 3 Requirements Issues

Questionable Trace

In this case, one or more traces specified for the requirement is weak. The requirement's traces could be strengthened by adding another trace(s), or by deleting a specified trace that appears inappropriate. A large number of traceability issues (i.e., 73) are in this category due to excessive weak traces and missing links. The analysis recommends candidate links to be deleted/added and are given in Appendix C.

Quality and Testability issues

Three types of quality issues identified are Incomplete/Inaccurate Requirement, Redundant Requirement, and Broad Scope/Ambiguous Wording. These are briefly described below.

Incomplete/Inaccurate Requirement

The requirement may be lacking desired or needed functionality, or the specified functionality may be inaccurate. Some of the issues identified (i.e., ESN-0210, SMC-8820) are due to references to "quick-look data". This reference should be changed to "expedited data" in ESN-0210 based on proposed changes in CCR 505-01-41-075. Approval of the CCR is expected to resolve this issue. SMC-8820 was not identified in the CCR and should be modified accordingly. Another accuracy issue was identified in SMC-3375. It included a phrase which appeared to be out of place in the sentence. A recommendation was made on the rewording of the sentence. Other requirements lacked complete functionality. For example, SMC-3421 requires that SMC analyze user feedback information, but it does not state which entities provide user feedback information to the SMC. The interface needs to be defined for the entities which provide user feedback information to the SMC.

Redundant Requirement

Functionality specified in the requirement appears to be redundant with another requirement at the same level. ESN-0240 states a generic need for the expandability of communications resources, whereas ESN-1207 describes to what extent the communications services should be expandable. The latter requirement more precisely specifies the quantity of growth required, whereas the former is more ambiguous and open-ended.

Broad scope/ Ambiguous Wording

The wording of the requirement is unclear or very general which could result in more than one interpretation. The scope or purpose of the requirement may be unclear due to missing details. SMC-1500 refers to performing "resolution services" in response to schedule conflicts. These services are not defined or limited, resulting in a broad scope. SMC-2400 requires that SMC support the management of training and certification programs for ECS. It is not clear what capabilities SMC is required to support. SMC-2520 requires that SMC shall evaluate received enhancement requests. Section 8.2.1.2.2 of the Functional and Performance Requirements Specification states that SMC sends enhancement proposals to the ESDIS Project Staff. It is unclear where the system enhancement requests originate.

7.3 Potential Issues

Potential problems that could arise in subsequent phases of the ECS development life cycle based on our requirements analysis findings are summarized as follows:

- Broad scope of the requirements: Use of word "Support"

A number of requirements have broad scope and /or ambiguous wording which are likely to result in unintended increase in the scope of the system, and in some cases loss of the intended functionality, when these requirements are decomposed further. The requirements in general use words like "shall provide", "shall accept", "shall generate" etc. providing a precise requirement. However, the F&PRS uses the words "shall support" and "shall provide support" in many requirements (e.g., SMC-1300, SMC-2400, SMC-2410, SMC-2420, SMC-2430, SMC-2450, SMC-2510). The intended capabilities are not specifically defined and, therefore, are open to varying degrees of interpretation.

- Non availability of peer links

  The Level 3 requirement traceability matrices analyzed do not include peer links. Proper tracking of the data flow within CSMS, however, depends on a close scrutiny of the peer links. In the absence of these links, there is a potential danger for breaks in the required data flow. Immediate action is recommended to identify, and subsequently, verify peer links.

8. LEVEL 2 REQUIREMENTS

The Level 2 requirements analysis focused on two traceability assessments from the ESDIS Project Level 2 Volume 1 ECS requirements: 1) assessment to the Level 1 Project Plan requirements, and 2) assessment to the Level 3 F&PRS. Results of these two analyses, conclusions, and recommendations are presented in this section.

8.1 Discussion Of Results

The ESDIS Project Level 2 Volume 1 ECS requirements are divided into the following areas: Overall System (Section 3.1.1), ECS Functions (Section 3.1.2), and ECS Evolutionary Approach Concepts (Section 3.2). There are a total of 267 ECS Level 2 requirements (Volume 1). Exhibit 8-1 shows the number of traceability issues found for each of these areas. Issues are grouped according to major, moderate, and minor depending on their severity. Additional detail is presented in the following sections.

	Rqmts	Major			Moderate			Minor			No Problems		
	Total	Trace	Qual	Test	Trace	Qual	Test	Trace	Qual	Test	Trace	Qual	Test
Section 3.1.1	69	10	n/a	n/a	2	n/a	n/a	26	n/a	n/a	31	n/a	n/a
Section 3.1.2	182	40	n/a	n/a	12	n/a	n/a	20	n/a	n/a	110	n/a	n/a
Section 3.2	16	4	n/a	n/a	1	n/a	n/a	3	n/a	n/a	8	n/a	n/a

EXHIBIT 8-1: Level 2 Volume 1 Requirements Traceability Analysis Results

8.2 Identified Problems

This section discusses problems identified during the Level 2 to Level 1 and Level 2 to Level 3 traceability analyses. Traceability problems found during the ECS Level 2 requirements analysis are grouped according to the problem classifications described in Section 3.3. An overview of results is presented below.

No Valid Trace Specified

All higher-level or lower-level traces specified for the requirement are incorrect, or no traces have been specified at all. Based on a total of 267 ECS Level 2 requirements, a total of 51 issues of this type were identified for Level 2 to Level 1 traces, and a total of 2 issues for Level 2 to Level 3 traces.

Questionable Trace

One or more traces specified for the requirement is weak. The requirement's traces could be strengthened by adding another trace(s), or by deleting a specified trace that appears inappropriate. Based on a total of 267 ECS Level 2 requirements, a total of 33 issues of this type were identified for Level 2 to Level 1 traces, and a total of 41 for Level 2 to Level 3 traces.

Other Issues

Other issues were identified while conducting the Level 2 traceability analysis which may or may not be a traceability issue. A total of 8 "other" issues were identified during our analysis. Additional detail is provided in the following section.

8.2.1 Traceability to Level 1 Requirements

Exhibit 8-2 summarizes the traceability issues found during the Level 2 to Level 1 Traceability Analysis. Detailed descriptions and recommendations for each of these requirements are in Appendix D. A summary of traceability issues is presented in Appendix C.

Problem	Description	Associated Level 2 Requirements
No Valid Trace Specified	All higher-level or lower-level traces specified for the requirement are incorrect, or no traces have been specified at all.	1552, 1273, 1555, 1429, 1492, 1457, 1463, 1468, 1574, 614, 1337, 1437, 1602, 1092, 885, 1152, 949, 1440, 1441, 1585, 1160, 580, 607, 1448, 1442, 625, 1569, 1165, 659, 624, 1451, 1453, 1604, 1242, 1235, 1131, 870, 576, 1455, 873, 1088, 1324, 1402, 1172, 1173, 1177, 1176, 1542, 1589, 1592, 1275
Questionable Trace	Some of the traces from Level 2 to Level 1 are questionable because they are weak or incomplete.	1465, 649, 635, 1565, 892, 583, 661, 894, 1493, 599, 876, 891, 1539, 1016, 1162, 1386, 1282, 1607, 1579, 1322, 1262, 1263, 1264, 1392, 1603, 1257, 1346, 1342, 1178, 1175, 1180, 1591, 1596

EXHIBIT 8-2: Summary of Level 2 to Level 1 Traceability Issues

No Valid Trace Specified

A total of 51 Level 2 requirements either had no links to Level 1 requirements specified, or all the specified links were inappropriate. Candidate traces were identified for 48 of the 51 requirements exhibiting this problem. Appropriate candidate traces could not be found for the remaining 3 requirements; these requirements are listed in Exhibit 8-3. Additional details, including recommended traces, are presented in Appendix C.

Level 2	Requirement Text

Requirement ID	
1574	The ECS shall maximize the use of COTS hardware and software.
659	The ECS shall be available 24 hours to provide information management services to EOSDIS users
1468	The ECS hardware and COTS software products shall be reviewed at 1 year intervals against commercially available, compatible hardware and software, and replaced when comparative cost analysis of cost vs. performance or required capacity increases indicates a need.

EXHIBIT 8-3: Level 2 Requirements Where No Candidate Leve1 Traces Could Be Identified

Questionable Traces

A total of 33 traceability issues are in this category due to excessive weak traces and missing links. The analysis recommends candidate links to be deleted/added and are given in Appendix C.

Other Issues

Other issues discovered while performing the Level 2 to Level 1 traceability analysis are described below.

- Requirement 1264 specifies that ECS support independent element, system and subsystem integration and test activities of the end-to-end EOSDIS, throughout its life. It is linked to Level 1 paragraph 4.2.8 which requires this functionality be available "without the interruption of operational support". It appears that this functionality may have been lost during the Level 1 to Level 2 requirements translation. Requirement 1264 should be modified accordingly to include this functionality.

- Missing requirements in the Level 2, Volume 1 document - 1275, 1438, 1564, 1602.

- In the Level 2, Volume 1 requirements document, requirement 1369 is duplicated, but the requirements text differs. One of the requirements is old. The new one is a Change 18. The old version should be removed.

- In the Level 2 document, requirements 635 and 1339 each appear twice. Requirements 1493 and 1442 exhibit the same problem.

- The Appendix containing the requirement/page index in the Level 2 document is incorrectly indexed.

8.2.2 Traceability to Level 3 Requirements

Exhibit 8-4 summarizes the traceability issues found during the Level 2 to Level 3 Traceability Analysis. Issues previously identified during the Level 3 to Level 2 traceability analysis are not repeated here. Detailed descriptions and recommendations for each of these requirements are in Appendix D. A summary of traceability issues is presented in Appendix C.

Problem	Description	Associated Level 2 Requirements
No Valid Trace Specified	All higher-level or lower-level traces specified for the requirement are incorrect, or no traces have been specified at all.	1577, 1579
Questionable Trace	One or more traces specified for the requirement is weak. The requirement's traces could be strengthened by adding another trace(s), or by deleting a specified trace that appears inappropriate.	1115, 1116, 954, 1122, 596, 1410, 1325, 1099, 1551, 1269, 1414, 1416, 1413, 1417, 1419, 1461, 1441, 1462, 1464, 1574, 659, 1165, 1017, 1018, 1016, 509, 1248, 1423, 1252, 1254, 1455, 1187, 906, 873, 872, 1346, 1180, 1545, 1588, 1589, 1590

EXHIBIT 8-4: Summary of Level 2 to Level 3 Traceability Issues

No Valid Trace Specified

A total of 2 Level 2 requirements either had no links to Level 3 requirements specified, or all the specified links were inappropriate. Specific candidate traces were identified for both of the requirements exhibiting this problem. Additional detail, including recommended traces, is presented in Appendix C.

Questionable Traces

A total of 41 traceability issues are in this category due to excessive weak traces and missing links. The analysis recommends the links to be deleted/added for all but 2 of the requirements exhibiting this problem. Additional candidate traces could not be found for the remaining 2 requirements; these requirements are listed in Exhibit 8-5. Recommended links to be deleted/added, where identified, are given in Appendix C. Additional detail is presented in Appendix D.

Level 2 Requirement ID	Requirement Text	Remarks

Level 2 Requirement ID	Requirement Text	Remarks
1441	The ECS shall support the generation and distribution of hard copy and photographic products	No trace available for the generation of photographic products.
1461	The transition from one version to another shall be contingent upon user acceptance of the new version.	Recommend a link be created to system wide requirements.

EXHIBIT 8-5: Level 2 Requirements Where No Additional Level 3 Traces Could Be Identified

Other Issues

Other issues discovered while performing the Level 2 to Level 3 traceability analysis are described below.

- Requirement 1252 is missing links to FOS Level 3 requirements. This requirement refers to system wide security protection. Existing links to the other segments are appropriate, but no links could be identified to FOS.

- Requirement 1577 did not have any links specified to Level 3 requirements. This requirement is very broad and although we recommended links to Level 3 requirements, it could realistically trace to a large number of Level 3 requirements.

- Requirement 1579 states that "ECS shall support the mission baseline identified in the ESDIS Project Level 2 Requirements Volume 0: Overall ESDIS Project Requirements.", however the mission baseline section was deleted from the Volume 0 document. Therefore, requirement 1579 and its associated Level 1 and Level 3 traces should be reviewed.

8.3 Potential Issues

Potential issues that could arise in subsequent phases of the ECS development life cycle based on our requirements analysis findings are summarized below.

Configuration Control of Traceability Data

The traceability data for linking requirements from Level 2 to Level 1 and Level 2 to Level 3 should be placed under formal ESDIS configuration control. We found a number of discrepancies and issues in the trace reports used in the latest analysis. These could have been avoided if the traceability data was controlled. For example,

- A duplication of the requirement number 632, was found with different text in the Level 2 to Level 1 trace report.

- Level 2 requirement 1555 was not included in the Level 2 to Level 1 trace report, but is in the Level 2 document.

- The Level 2 to Level 1 trace report shows recent traceability updates, correcting earlier errors.

- The Level 2 to Level 1 trace report shows an incorrect requirement number 420 associated with the Level 2 paragraph 3.1.2.1.M. The correct requirement number is 1325.

- The Level 2 to Level 1 report incorrectly associates some requirement numbers with Level 1 paragraphs.

- The Level 2 to Level 1 report has duplications of Level 2 requirements 632 and 1369 on different pages of the report.

- Some Level 2 requirements were missing from the latest Level 2 to Level 1 report.

Incomplete Trace

The Level 2 requirement 1441 requires generation and distribution of photographic products by the ECS, and this part of the requirement has not been traced to any Level 3 requirement. The Level 2 requirement 1441 needs a review.

Excessive Linkages

Many Level 2 Volume 1 requirements are linked to an excessively large number of Level 3 requirements. Exhibit 8-6 shows the distribution of the number of Level 3 traces for the Level 2 requirements.

Number of Traces	Number of Requirements	Percentage of Requirements
0 to 10	153	57%
11 to 20	58	22%
21 to 30	30	11%
31 to 40	17	7%
41 to 50	6	2%
over 50	3	1%

EXHIBIT 8-6: Distribution of the Number of Level 3 Traces for Level 2 Requirements

The benefits of having parent-child linkages is reduced when large numbers of links are identified. This could lead to difficulties during verification of the intended functionality. The level of detail in the Level 2 requirements varies greatly. Some Level 2 requirements are very broad and link to many Level 3 requirements, while other Level 2 requirements are more detailed and link to just a few Level 3 requirements. The Level 2 requirement 651, has been linked to as many as 95 Level

3 requirements. The reason for this is to a large extent, the broad scope of the requirement which reads "The ECS shall provide a convenient access to EOS data and data information and subsets thereof." In the absence of an explanation regarding the scope of the "convenient access", the requirement might have been decomposed into a large number of Level 3 requirements, resulting in a large number of traces and an unintended expansion of the scope of the system. Exhibit 8-7 lists some of the Level 2 requirements with the highest number of linkages to Level 3.

Level 2 Requirement ID	Number of Traces
1249	37
1187	38
1243	43
599	45
1262	48
876	49
1322	50
1252	54
1339	63
651	95

EXHIBIT 8-7: Level 2 Requirements With Highest Number of Traces to Level 3

Even though it is not possible to set an upper limit to the number of linkages, efforts should be made to reduce the number ensuring that no intended functionality is lost. In general, we feel that requirements with more than 20 traces should be reviewed for weak links, and the weak links should be deleted. Although these links may be valid, they do not provide any additional connectivity than the existing stronger links.

9. CONCLUSIONS

This section presents the conclusions of the IV&V ECS requirements analysis activity. The conclusions address both technical integrity of the requirements as well as user satisfaction issues with respect to Level 3 EOSD, SDPS, FOS, CSMS, and Level 2 Volume 1 ECS requirements.

9.1 Technical Integrity

After the submission of the Preliminary Requirements Analysis report on October 28, 1994, the Level 2 requirements had two more changes, through CH-21, and the F&PRS had six changes, through CH-07. Additionally, our analysis reflects changes proposed in the "quick-look" CCR [8], which specifies the reduction of quick-look data to "expedited data". In this regard, we identify several traceability issues that need to be addressed as a result of the proposed changes. Updated Level 3/Level 2 [9,10] and Level 2/Level 1 [11]) traceability reports were provided to the IV&V team during the course of our analysis; results reported reflect these updates. The provided trace reports do not have peer links defined for Level 3 requirements. Identification and subsequent IV&V verification of peer links will improve the technical integrity of the requirements. The requirements analysis has identified 85 major traceability issues. Although rated as "severe", our analysis indicates that appropriate links could be established for most of these requirements resulting in no major concerns of technical integrity in the F&PRS. Conclusions on the technical integrity of the ECS segments are given below.

EOSD

A total of 127 EOSD requirements were evaluated for technical integrity. There were 2 major issues identified during the analysis. Both of these were traceability issues classified as severe, due to missing or inappropriate traces to Level 2 requirements. Our analysis identifies and recommends appropriate links to the Level 2 requirements.

SDPS

A total of 518 SDPS requirements were evaluated for technical integrity. There were 20 major issues identified, including 19 traceability issues, and 1 quality issue. All of the 19 major traceability issues involved Level 3 requirements with missing or incorrect traces to Level 2 requirements. Our analysis identifies appropriate links to Level 2 requirements to all but two of these. Although we were unable to identify Level 2 links for two requirements, we were able to identify a Level 1 link for one of them, IMS-0460. This requirement, which addresses the capability to accept metadata problem reports from users and inform the PGS quality assurance staff of the problem, could be traced to the Level 1 requirement 8.2.4.3, "User Involvement--Users shall be involved in all aspects of EOSDIS development and operations that effect user services".

FOS

A total of 363 FOS requirements were evaluated for technical integrity; only one major issue was identified - a traceability issue, involving a Level 3 requirement that had an incorrect trace to a Level 2 requirement. The analysis indicated an appropriate link could be established for the requirement.

CSMS

A total of 211 CSMS requirements were evaluated for technical integrity. There were 9 major issues identified during the analysis, all related to traceability. All of these traceability issues involved Level 3 requirements with missing traces to Level 2 requirements. Our analysis identifies and recommends appropriate Level 2 links for these requirements.

Level 2 Requirements

A total of 267 Level 2 Volume 1 ECS requirements were evaluated for technical integrity. There were 54 major traceability issues identified during the analysis. These issues involved Level 2 requirements that were missing traces to either Level 1 or Level 3. Our analysis identifies and recommends appropriate links in all but 3 of the issues. Additionally, the issues indicated in section 8.2.1 "Other Issues" were identified during the Level 2 to Level 1 assessments. One Level 2 requirement (1264), was traced to a Level 1 paragraph which contained more details than the Level 2 requirement. This should be addressed quickly to ensure functionality is completely translated from Level 1 to Level 2. The remaining issues are editorial problems with the Level 2 Volume 1 requirements document (e.g., missing requirements, duplication requirements). While not of major technical concern, these problems should be addressed to prevent a flow down of problems, to prevent misinterpretation, and to prevent the possibility of requirements being overlooked. The issues indicated in Section 8.2.2 "Other Issues" were identified during the Level 2 to Level 3 assessments. These include a Level 2 requirement (1252) which was not completely traced to Level 3, a very broad Level 2 requirement (1577), and a Level 2 requirement (1579) that should be reviewed for possible deletion.

9.2 User Satisfaction

The Requirements analysis identifies issues and potential problems, some of them with a severity rating of '3' (i.e., "major"). However, the issues can be resolved based on the recommendations given in this report. We are of the view that the Level 3 requirements are potentially capable of achieving user satisfaction. We believe the following issues should be addressed from the point of view of achieving user satisfaction:

- IMS-0460 requires the provision of "the capability to accept metadata problem reports from users, and inform the PGS quality assurance staff of the problem". The currently Level 2 traces, 1287 and 586, address the access of data. No Level 2 trace could be identified for reception of "problem reports from users". However, the Level 1 requirement 8.2.4.3 provides a strong link to this Level 3 requirement. We therefore recommend the issue be resolved by suitable changes to the Level 2 requirement.

- As pointed out in section 8.2 of this report, the Level 2 requirement 1441, regarding the generation and distribution of photographic products is not in the Level 3 requirements. Not withstanding recent advances in the techniques for digital data visualization and image display, availability of photographic products are important for user satisfaction. This functionality, as given in the above Level 2 requirement should be provided in Level 3 requirements also.

- Phased implementation of the ECS has the potential to strongly affect user interaction during transition from one version to the other, as addressed in Level 2 requirements 1461 and 1462. These requirements are missing links, or have only weak links to Level 3 requirements. Level 2 requirements 1461 specifies that transition from one version to another is contingent upon user acceptance of the new version. We could not identify a suitable Level 3 requirement addressing user feedback this version acceptance process. These requirements are very important in achieving long-term user satisfaction, therefore, appropriate links should be established.

9.3 Trends and Projections

This analysis represents an update to the IV&V Preliminary Requirements Analysis Report, submitted on October 28, 1994. It is based on two additional CCB changes to the Level 2 Volume 1 requirements specification (i.e., through CH-21) and six additional CCB changes to the F&PRS (i.e., through CH-07). Our findings also include proposed changes to the F&PRS which are pending CCB approval (i.e., change quick-look data to expedited data). Although the trace reports we received for our analysis did not appear to reflect these CCB document changes, our traceability analysis was based on reviewing the given traces with respect to the updated requirements. Our observations regarding trends in the integrity of the requirements are as follows:

- We found that the number of traceability issues with severity rating "3" (i.e., major) increased when compared to our preliminary analysis. This increase is primarily due to the omission of Level 2 links to some Level 3 requirements in the traceability reports supplied to us. Our analysis identifies and recommends suitable Level 2 links for most of these requirements, which when accepted and implemented will result in the over all improvement of the technical integrity of the requirements.

- It was noted that most of the Level 3 requirements remain unchanged, despite recommendations made in the Preliminary Requirements Analysis Report. Timely consideration of raised issues is very important in maintaining the technical integrity, and in maintaining quality within schedule and cost constraints.

It was also noted that flow down of FOS requirements from Level 2 to Level 3 do not incorporate most of the CH-05 requirement changes involving quick-look and DAR requirements that have been deleted. The effect is a perpetuation of obsolete Level 3 requirements that may unnecessarily consume program resources during the development phase.

10. RECOMMENDATIONS

This section presents recommendations for future requirements analysis work, recommended solutions to important problems and risk management recommendations.

10.1 Areas Requiring Further Analysis

Several areas are recommended for additional analysis:

ECS Release Specific Requirements Analysis: ECS release-specific requirements will be targeted at specific levels of functional capability and performance. Thus far, the requirements analysis has focused on ECS Level 3 Functional and Performance Requirements. Future IV&V analyses will be focused on specific capabilities and performance levels allocated to a release. Emphasis will be placed on traceability between Level 3 release-specific requirements and Level 4 requirements, as well as the adequacy of the allocation of requirements to ECS releases.

Verification of Peer Links: For this analysis, Level 3 traceability reports did not identify the peer links between different elements of the ECS. In view of the complex data flows within ECS, it is essential to identify the peer links and subject them to IV&V analysis, to ensure adequate data flow functional dependencies.

Level 3 to Level 4 Traceability: The ECS Level 3 requirements are structured according to the segment/element architecture (EOSD, SMC, PGS, etc.). The Level 3 requirements are contractual specifications and are therefore the basis for the evaluation of the delivered system. The ECS Level 4 requirements are being organized according to the "services" architecture. It is essential to verify that changes to this "services" type of architecture do not affect traceability, and that the intended functionality is completely carried through to the next level. Traceability is essential for the certification of the delivered system. We recommend that IV&V focus on the developer's traceability efforts to make sure that traceability is carried through to Level 4 and into the later life cycle stages.

10.2 Solutions to Important Problems

Requirements Technical Integrity Problems: The specific requirements problems cited in this analysis should be reviewed and addressed by the ESDIS Project and HAIS, as appropriate. We recommend that problems having a "major" severity rating be given higher priority.

Inconsistent Traceability Reports: As stated in Section 3.2, our analysis is based on traceability reports that came from two different sources (i.e., Level 2/3 and Level 2/1) which are maintained using different tools. Furthermore, each report was based on a different version of the Level 2 Volume 1 requirements specification. Without an integrated requirements baseline, certain assumptions had to be made regarding the basis of the IV&V analysis. Our recommended solution is to have all EOSDIS requirements incorporated into an RTM baseline under ESDIS Project configuration control.

Definition of the scope of the requirements: We recommend a review of the scope of the requirements with identified quality issues, and others using words like support, coordinate, etc.,

to clearly define the functionality. This may be accomplished by carefully reviewing Level 4 requirements that link to Level 3 requirements in question to insure the Level 4 functionality meets the ESDIS project requirements.

Identification of Peer Links: There is immediate need to identify the peer links between the Level 3 system level requirements of the ECS, to the corresponding requirements in the subsystems of SDPS, CSMS, and FOS. This will solidify the ECS internal interfaces ensuring that no requirement or data flow is lost when the requirements are further decomposed.

10.3 Risk Management

Each issue and problem raised in this document and detailed in Appendix D represents a potential risk to technical integrity, schedule, and costs. Such risks can be managed and mitigated by addressing the issues presented here, and quickly implementing an approved solution.

There is a noticeable time lapse in incorporating approved changes documented in CCRs into the Level 3 documentation and trace reports. F&PRS CH-05 was baselined on 1/27/93 as noted in the ECS Volume 1 Level 2 requirements document, yet the corresponding Level 3 traces have not been changed or deleted to reflect the Level 2 changes. Additionally, it was noted that many recommendations previously made in the October 28, 1994 Requirements Analysis Report, have not been incorporated. Resources are thus being consumed unnecessarily on Level 3 requirements that should have been removed entirely or changed, and technical integrity is at risk.

Time lapses in incorporating changes are perhaps inevitable in a program of this size, but there is currently a risk for future cost and schedule overruns, and loss of technical integrity due to the slow process of change incorporation. This issue must be addressed by ESDIS Project and HAIS before a snowball effect of delays gains momentum. We recommend the following:

- Review and streamline the CCR approval process.
- Review and streamline approval process for recommendations made by the IV&V contractor.
- Review and streamline configuration management procedures so that approved changes are quickly incorporated into lower level documentation.
- Provide a feedback loop on recommendation approval and rejection to the IV&V contractor so that issues won't continue to be raised inappropriately.

Early implementation of these recommendations will help to ensure that the EOSDIS program remains on track.

APPENDIX A: REQUIREMENTS ANALYSIS GUIDELINES

Each requirement at levels 2, 3, and 4 will be evaluated in terms of three technical integrity categories: 1) traceability, 2) quality, and 3) testability. Categories will be evaluated independently of each other (i.e., it is possible that a requirement will evaluate badly in one category and well in another). The result of each evaluation will be quantified using a rating scale of 0 (no problems) to 3 (major problems) according the specific definitions associated with each category. A rating of 4 is a "flag" which indicates an unknown state: not analyzed or TBD pending further information. The technical integrity evaluation process is illustrated in Exhibit A-1.

Each evaluation will include a brief engineering rationale which substantiates the assigned rating. Whenever an evaluation indicates multiple problems at differing levels of severity, the assigned rating will reflect the most severe case. The engineering rationale will sufficiently characterize all (most severe and other) identified problems so that corrective measures can be effectively applied to the collection.

Each requirement metrics database entry will include current IV&V evaluation status information. Status will be expressed by a numeric code indicating what work (if any) is in-progress and the date on which the current status became effective:

Status	Meaning	As of Date
4	Not Yet Analyzed	n/a
3	Analysis in progress	mm/dd/yy
2	IV&V Review in-progress	mm/dd/yy
1	Evaluation complete	mm/dd/yy
0	Evaluation reported to NASA	mm/dd/yy

The technical integrity requirements evaluation process will include an analysis activity followed by review(s) before the results are formally reported to non-IV&V personnel. Requirements which evaluate, in every category as 0 or 1 only require peer review. Requirements which evaluate, in any category, as 2 or 3 require peer review followed by IV&V management review.

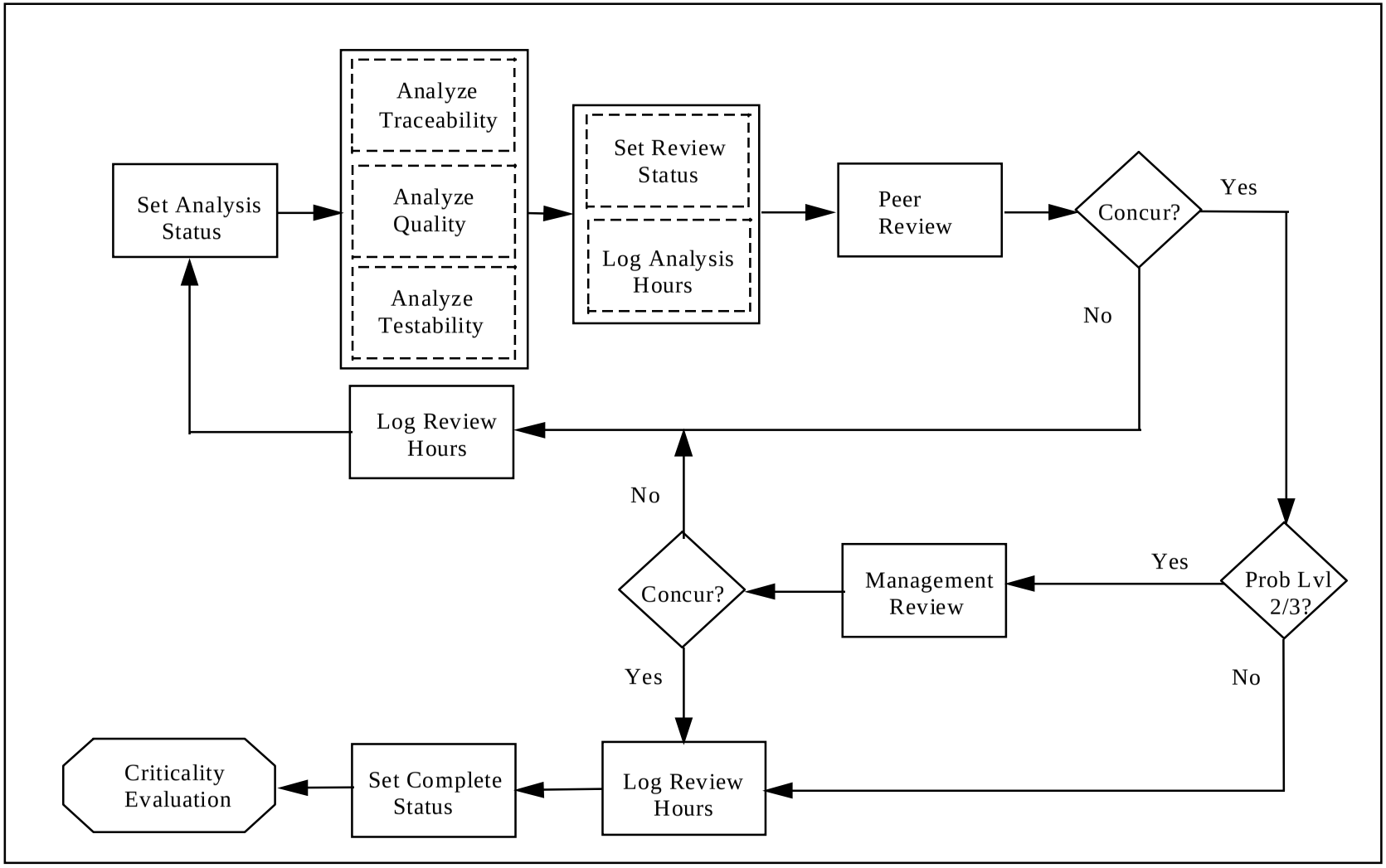


EXHIBIT A-1: Requirements Analysis - Technical Integrity Evaluation Process

Requirements traceability evaluation focuses on the existence and validity of the logical connections (linkages) between requirements. Trace analysis (validity) is distinct from trace verification (existence) which is discussed in ISVVP Section 2.1. Trace verification is focused on verifying that trace linkages exist and that the linkages are between existing requirements. Trace analysis is a part of requirements analysis and is done to determine if the trace linkages have technical validity. In general, IV&V analyzes linkages identified by system developers. In some cases, where the linkages do not exist, trace analysis may be extended to determining the linkages between two requirement levels. The process for evaluating existing trace linkages is similar to the process of identifying the linkages. There are two categories of traceability analysis: parent-child traceability and peer-to-peer traceability.

Parent-child traceability - Requirements at Level 2 and below should trace to one or more parent requirement to assure that the scope of the system is not being expanded. Conversely, requirements from Level 1 down should trace to child requirements to assure that the scope of the system is not being reduced. Parent-child requirement trace analysis is focused on two criteria, scope and completeness. Peer requirement trace analysis is focused on consistency of requirements

> Scope - The linkages for each requirement are analyzed to verify that the child requirements are within the scope of the parent requirement. Since many requirement at Levels 1, 2 and 3 are compound requirements, the trace linkages are often many to many. In situations where a child requirement has multiple parents, each parent requirement must be examined to determine if the child requirement is within scope.
>
> Completeness - The linkages for each requirement are analyzed to verify that the parent requirement is fully addressed in one or more child requirements. All aspects of the parent requirement must be addressed in the linked child requirement(s). Generally, child requirements are expected to extend the level of detail which is given in the parent requirement.

Peer-to-peer traceability - Peer-to-peer requirement linkages are analyzed to determine if requirements have consistency across system boundaries. Peer linkages typically exist for requirements which define interfaces between system components or services. For example, wherever a requirement states that a data item is received from, or is provided to, an external element, a comparable peer requirement should exist in the external element. As part of the Key Interface Analysis (ISVVP Section 4.9) IV&V examines peer linkages for system components which are subject to Interface Requirement Documents. Peer linkages for intra-component boundaries (e.g., between the ECS PGS and DADS) are analyzed as part of the Requirements Task (ISVVP Section 4.5).

Whenever peer linkages are provided, each linkage is analyzed for correctness and consistency. Correctness means that the linked requirements are truly peers. Consistency means that the peer linked requirements correctly describe the same requirements from the point of view of the two interfacing components.

Whenever peer linkages are not provided, each interface requirement is analyzed to determine if a peer should exist. If a peer requirement is found, it must meet the correctness and consistency criteria described in the previous paragraph.

The results of linkage problems identified during trace analysis and during trace validity are assessed using the following severity guidelines.

Traceability Verification (Existence) Problem Severity Guidelines		
Major	**Moderate**	**Minor**
There is no linkage from this requirement to the next higher or lower level specification. Recommend, in the engineering rationale, to which higher or lower level specification this requirement should be linked.	Necessary linkages to peer requirements are incomplete, or do not exist. Recommend, in the engineering rationale, how the linkage could be made complete, or to which peer requirement(s) the linkage should be made.	N/A

Traceability Validation (Analysis) Problem Severity Guidelines		
Major	**Moderate**	**Minor**
The requirement is linked incorrectly to the next higher or lower level specification. Recommend, in the engineering rationale, to which higher or lower level specification this requirement should be linked.	a) Requirement linkage to next higher or lower level specification is questionable. State in the engineering rationale why the linkage is questionable, how the linkage might be fixed, or to what other requirement the linkage should be made.	Correct linkages exist, but wording or requirements could be changed to strengthen the linkage, make it clearer, etc. Recommend, in the engineering rationale, what changes should be made to strengthen the linkage.

A requirement trace rating is assigned using composite Existence and Validity criteria described in the above tables. The rating assigned represents the most severe problem.

The description of each category and associated evaluation criteria are described on the following pages.

Traceability - Each requirement must be correctly derived from one higher level specification and all peer-to-peer (same level) relationships must be correctly identified.

Key Word - Linkages

Rating Definition

3 Major - Requirement has no linkage to any next-higher level specification.
2 Moderate - Requirement linkage is questionable or peer linkage(s) are incomplete.
1 Minor - Linkages exist, but could be strengthened by rewording, editing the requirement, or the addition or deletion of links.

0 No traceability problems identified.

Evaluation Guidelines

Requirements traceability evaluation focuses on the existence and validity of the logical connections (linkages) between requirements. In this context, the substance of each requirement is examined only to the extent needed to determine connectivity correctness.

Assign If

3 There is no link from this requirement to any next-higher level specification, OR requirement is incorrectly linked to a next-higher level specification. Recommend, in the engineering rationale, to which next-higher level specification this requirement should be linked, and why.

2 a) Requirement linkage to next-higher level specification is questionable or incomplete. Recommend, in the engineering rationale, why linkage is questionable, how the linkage might be fixed, or to what other requirement the linkage should be made.

b) Necessary linkages to peer requirements are incomplete, or do not exist. Recommend, in the engineering rationale, how the linkage could be made complete, or to which peer requirement(s) the linkage should be made.

1 Correct linkages exist, but wording of requirements, or addition or deletion of traces, could be changed to strengthen the linkage, make it clearer, etc. Recommend, in the engineering rationale, what changes should be made to strengthen the linkage.

Quality - Requirements must be of high technical quality: accurate, unambiguous, complete, flexible, and consistent.

Rating Definition

4 Not analyzed
3 Major - serious substantive problems exist.
2 Moderate - some manageable substantive problems exist.
1 Minor - clarity and/or editorial problems exist.
0 No quality problems identified.

Evaluation Guidelines

Quality evaluation guidelines are illustrated in Exhibit A-2. Problem severity determination guidelines are illustrated in Exhibit A-3.

QUALITY ATTRIBUTES	KEY WORDS	DEFINITION	EVALUATION GUIDELINES
Accuracy	Error	Requirements must be free from error.	Accuracy evaluation focuses on correctness of the requirement.
Ambiguity	Interpretation	Requirements must be stated so they are not open to interpretation.	Ambiguity evaluation focuses on the interpretation of each requirement. In this context, the content of each requirement is examined for clarity to ensure that only one interpretation is implied.
Completeness	Detail	Requirements must completely specify the product.	Completeness evaluation focuses on the existence of an overall goal or function being entirely specified, void of insufficient function or detail.
Consistency	Agreement Harmony Accord	Requirements must be consistent with one another, with interfacing subsystems, and with those at the next higher and lower levels.	Consistency evaluation focuses on the existence and the validity of the logical and the functional relationships between the requirements (i.e.,uniformities and standards in notation; technical non-contradictions in concept and approach, architecture and structure)
Flexibility	Design Constraints	Requirements must be stated to allow design alternatives and system adaptability within the allowable bounds of system constraints.	Flexibility evaluation focuses on the degree to which the requirement constrains the design options of the developer or limits his design approach. (Note: This guideline must be applied appropriately to the requirement document level.)

EXHIBIT A-2: Requirement Quality Evaluation Guidelines

ATTRIBUTES	MAJOR	MODERATE	MINOR
Accuracy	Requirement contains erroneous values, information, and/or direction that could result in serious failure of system implementation. Identify, in the engineering rationale, where the inaccuracy arises; consequences to the implementation of the requirement as written, and suggest possible correct values/functionality, if known.	Requirement contains values, information, and/or direction that is in error, but implementation will not likely result in serious system failure. Identify, in the engineering rationale, where the inaccuracy arises; consequences to the implementation of the requirement as written, and suggest correct values/functionality, if known.	Requirement contains editorial errors, typos, etc. Recommend, in the engineering rationale, appropriate wording, spelling, etc.
Ambiguity	Requirement cannot be reasonably interpreted. Implementation of this requirement using any interpretation will likely result in the intended functionality not being implemented. Describe, in the engineering rationale, why the requirement cannot be interpreted; the consequences of not changing the requirement, and suggest alternatives for rewording to make the requirement understandable.	Requirement can be interpreted in more than one way. One of those ways may yield wrong or undesired functionality. Describe, in the engineering rationale, each interpretation, and what part of the requirement, as written, causes the ambiguity the possible consequences of not changing the requirement, and suggest alternatives for rewording to make the requirement understandable.	Requirement needs some clarification, but basic functionality is not in question. Describe, in the engineering rationale, what clarifications are needed, and suggest alternative wording to provide this clarification.
Completeness	Requirements for a major function are missing or incomplete. Describe, in the engineering rationale, what the missing functions are and what needs to be added to correct the requirement insufficiency.	Requirements are written at a level of detail which does not fully specify the desired functionality. Explain, in the engineering rationale, the appropriate level of detail required	Requirement states all necessary functions, but some clarification is needed. Explain, in the engineering rationale, the clarification required.
Consistency	Requirement is not in agreement with overall mission and/or desired functionality. Describe, in the engineering rationale, why the requirement is not in agreement. Suggest rewording or other changes (i.e. placement in another section), that are needed.	Agreement of the requirement with overall mission goals and/or desired functionality is questionable. Describe, in the engineering rationale what gives rise to questionable wording, and suggest alternative wording or other changes, that are needed.	Requirement is in agreement with overall mission and/or desired functionality, but clarifications are needed; and/or multiple terms are used for the same functionality. Describe, in the engineering rationale, what clarifications are needed, or what terms are used interchangeably.
Flexibility	Requirement states the design outright. Specifies COTS and/or technologies which greatly restrict system design options. Identify, in the engineering rationale, what constraints are; recommend alternative wording.	Requirement implies use of a specific design method, and/or tooling. Identify, in the engineering rationale what these constraints are, and recommend alternative wording.	Requirement slightly limits design alternatives. Identify, in the engineering rationale what these constraints are and why they are limiting to the design.

EXHIBIT A-3: Severity Rating Guidelines For Quality Problems

Testability - Requirements must be stated in quantitative terms that can be translated into acceptance criteria.

Key Word(s) - Acceptance Criteria

Rating Definition

3 Major - Not testable.
2 Moderate - Testable, but acceptance criteria cannot be formulated.
1 Minor - Testable; minor clarifications are needed.
0 No testability problems identified.

Evaluation Guidelines

Requirements testability focuses on whether requirements are testable, contain enough information to suggest a test approach, and provide quantitative criteria to evaluate test results.

Assign If

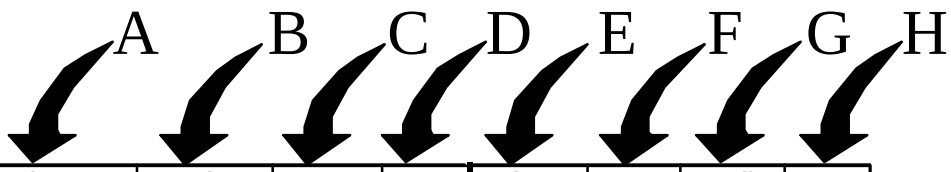
3 Requirement does not provide a testable function or deliverable. Summarize requirement deficiencies.

2 Requirement yields testable function, but does not give acceptance criteria, allow formulation of acceptance criteria, or infer a test approach. Describe, in the engineering rationale, what additional functional detail and/or references are needed in order to define a test approach and/or quantitative acceptance criteria.

1 Most acceptance criteria requirements can be directly extracted from the requirement text. Some clarification is needed for some terms and/or definitions in order to eliminate any minor assumptions. Describe what clarification is needed or minor assumptions related to this requirement.

APPENDIX B: ARDB DESCRIPTION AND USE

Exhibit B-1 is a guide to the Automated Requirements Data Base (ARDB) listed in Appendices C, D, and E. The ARDB is the repository for the requirements analysis and traceability data and is currently implemented using Microsoft Excel with embedded Word documents. Each column has been identified with a letter. The corresponding definition is listed below.



Rqmt Id	Update	Status	RTM	Tech Int	Trace	Quality	Test
DADS0010	6/26/95	1			0	0	0
DADS0020	6/26/95	1			0	0	0
DADS0070	6/26/95	1			0	0	0
DADS0100	6/26/95	1			0	0	0
DADS0110	6/26/95	1			1	0	0
DADS0120	6/26/95	1			1	1	0
DADS0130	6/26/95	1			0	2	0
DADS0140	6/26/95	1			1	1	0
DADS0145	6/26/95	1			1	0	0
DADS0150	6/26/95	1			0	1	0
DADS0160	6/26/95	1			0	1	0
DADS0170	6/26/95	1			1	0	0
DADS0175	6/26/95	1			1	1	0
DADS0180	6/26/95	1			1	1	0
DADS0190	6/26/95	1			1	0	0
DADS0200	6/26/95	1			0	0	0

EXHIBIT B-1: ARDB Description

A - The requirement identifier.
B - Set by the IV&V analyst when an analysis or review begins, or when an analysis is completed. Each time the Status is changed, the update field is also changed.
C - Status of the requirement analysis (0=Evaluation reported to NASA, 1=Evaluation complete, 2=IV&V Review in progress, 3=Analysis in progress, 4=Not yet analyzed).
D - TBD link to RTM, which will import requirement text directly from that tool.
E - Technical Integrity requirements analysis for this requirement. This column contains an icon which points to an embedded MS Word 6.0 document.
F - Traceability rating for this requirement (number from 0-3). See appendix A for details.
G - Quality rating for this requirement (number from 0-3). See appendix A for details.
H - Testability rating for this requirement (number from 0-3). See appendix A for details.

APPENDIX C: TRACEABILITY ISSUES SUMMARY

Traceability issues identified for each of the Level 3 ECS requirements areas are summarized in Exhibits C-1 through C-10. Exhibit C-11 summaries traceability issues for Level 2 requirements that were not previously identified by the Level 3 analysis. Additional traceability analysis detail is presented in Appendix D.

Summary traceability information in this Appendix is organized as follows:

L3 Rqmt Id	Severity Rating	Problem Description	Recommendation	Probler
EOSD0015	2	weak trace, incomplete trace	delete trace to 1234. add trace to 1539	
EOSD0030	2	incomplete trace	add traces to 570, 625, 656, 1167, 1274, 1436	
EOSD0700	1	weak trace	delete trace to 1322	
EOSD0760	1	weak trace	delete trace to 1282	
EOSD1030	1	weak trace	delete trace to 945	
EOSD1085	3	no traces specified	add trace to 1134	
EOSD1680	1	weak trace	delete trace to 1263	
EOSD1690	1	weak trace	delete trace to 1263	
EOSD1605	2	incomplete trace	add trace to 1414	
EOSD1607	1	trace could be strengthened	add trace to 1093	
EOSD1608	1	trace could be strengthened	add trace to 1093	
EOSD1740	1	weak trace	delete trace to 623	
EOSD1750	1	weak traces	delete traces to 607, 651	
EOSD1760	1	weak traces	delete traces to 623, 662	
EOSD1770	1	weak trace	delete trace to 625	
EOSD2430	2	incomplete trace	add trace to 1256	
EOSD2440	2	incomplete trace	add trace to 1256	
EOSD2550	1	trace could be strengthened	add trace to 1253	
EOSD2555	3	no traces specified	add traces to 1252, 1257	
EOSD2640	1	trace could be strengthened	add trace to 1252	
EOSD2650	1	trace could be strengthened	add trace to 1257	

EOSD3820	1	trace could be strengthened	add trace to 1020
EOSD4036	1	weak trace	delete trace to 625
EOSD4100	1	trace could be strengthened	add trace to 1249
EOSD5110	1	trace could be strengthened	add traces to the following Volume 0 rqmts: 3359, 3360, 3371, 3372, 3373, 3374,
EOSD5200	1	weak traces	delete the following traces to Volume 0 rqmts: 3363, 3365
EOSD5210	1	weak trace	delete trace to 3364 (Volume 0)
EOSD5230	2	incomplete trace	add trace to 3364 (Volume 0)

Exhibit C-1: EOSD Level 3 to Level 2 Traceability Issues Summary

L3 Rqmt Id	Severity Rating	Problem Description	Recommendation
FOS-0030	2	incomplete trace	add links to 1325, 1334, 571

Exhibit C-2: FOS (Segment Level) Level 3 to Level 2 Traceability Issues Summary

L3 Rqmt Id	Severity Rating	Problem Description	Recommendation
EOC-2180	1	trace could be strengthened	add trace to 1557
EOC-2190	1	trace could be strengthened	add trace to 1443
EOC-2200	1	trace could be strengthened	add trace to 1407
EOC-2250	1	trace could be strengthened	add trace to 571
EOC-2350	1	trace could be strengthened	add trace to 1325
EOC-2482	1	trace could be strengthened	add trace to 1334
EOC-3080	1	trace could be strengthened	add trace to 1137
EOC-3160	2	trace not appropriate	delete trace to 143. add trace to 1331
EOC-4005	1	trace could be strengthened	add trace to 1234
EOC-4008	3	incorrect trace	delete trace to 1540. add trace to 1434
EOC-4060	1	trace could be strengthened	add trace to 1413
EOC-4100	1	trace could be strengthened	add trace to 1561
EOC-4130	1	trace could be strengthened	add trace to 1403
EOC-4160	1	trace could be strengthened	add trace to 580
EOC-5050	1	weak trace	delete trace to 1337
EOC-5110	1	additional trace needed	add trace to 1332
EOC-5200	1	trace could be strengthened	add trace to 1417
EOC-6080	1	trace could be strengthened	add trace to 1404, 1552
EOC-6150	1	trace could be strengthened	add trace to 1418
EOC-6195	1	trace could be strengthened	add trace to 1418
EOC-7115	1	trace could be strengthened	add traces to 1346, 1142
EOC-7116	1	trace could be strengthened	add traces to 1346, 1142
EOC-7125	1	trace could be strengthened	add trace to 1559
EOC-7140	1	trace could be strengthened	add traces to 1404, 1602
EOC-7150	1	trace could be strengthened	add traces to 1404, 1602
EOC-7160	1	trace could be strengthened	add traces to 1404, 1602
EOC-8372	1	trace could be strengthened	add traces to 1559, 1564
EOC-8380	1	trace could be strengthened	add traces to 1325, 547

Exhibit C-3: FOS/EOC Level 3 to Level 2 Traceability Issues Summary

L3 Rqmt Id	Severity Rating	Problem Description	Recommendation

ICC-2010	1	trace could be strengthened	add trace to 1325
ICC-2015	1	trace could be strengthened	add trace to 571
ICC-3020	2	incomplete trace	consider adding traces to 637, 1101, 1269, 1270, 1325
ICC-4090	2	incomplete trace	add trace to 1553
ICC-4170	1	trace could be strengthened	add trace to 1554
ICC-4470	2	incomplete trace	consider adding traces to 1602, 1404.
ICC-4830	1	trace could be strengthened	add traces to 1602, 1404

Exhibit C-4: FOS/ICC Level 3 to Level 2 Traceability Issues Summary

L3 Rqmt Id	Severity Rating	Problem Description	Recommendation
SDPS0025	1	weak trace	delete trace to 1131
SDPS0030	1	weak trace	delete trace to 636
SDPS0040	3	traces not appropriate (requirement should be deleted pending CCR 505-01-41-075 approval)	delete traces to 583, 874, 954, 1273
SDPS0085	3	no traces specified	add trace to 1459
SDPS0095	3	no traces specified	add trace to 1397
SDPS0100	2	incomplete trace	add trace to 1402
SDPS0115	3	no traces specified	add trace to Level 2 requirement(s)
SDPS0130	1	trace could be strengthened	add trace to 625
SDPS0150	3	traces not appropriate (requirement should be deleted pending CCR 505-01-41-075 approval)	delete traces to 583
SDPS0160	3	traces not appropriate (requirement should be deleted pending CCR 505-01-41-075 approval)	delete traces to 583
SDPS0170	1	trace could be strengthened	add trace to 1607

Exhibit C-5: SDPS (Segment Level) Level 3 to Level 2 Traceability Issues Summary

L3 Rqmt Id	Severity Rating	Problem Description	Recommendation
PGS-0290	1	weak traces	delete traces to 1166
PGS-0295	1	weak trace	delete traces to 518, 635
PGS-0360	1	weak traces	delete traces to 906, 1252
PGS-0370	2	traces are not appropriate	delete traces to 518, 635, 894, 1131. add traces to 1593, 1595, 1597.
PGS-0430	3	incorrect traces	delete traces to 1252, 1593. add traces to 1403, 599.
PGS-0450	2	traces are not appropriate	delete traces to 649, 885, 1092, 1152. add traces to 570, 661, 1093.
PGS-0455	3	incorrect traces	delete trace to 1156. add traces to 1437, 892.
PGS-0456	3	incorrect traces	delete trace to 1156. add traces to 1437, 892.
PGS-0470	1	weak trace, trace could be strengthened	delete trace to 1155. add trace to 885.
PGS-0480	1	weak traces	delete traces to 583, 649.
PGS-0602	1	trace could be strengthened	add traces to 1465, 1466
PGS-1015	1	weak trace, trace could be strengthened	delete trace to 1156. add traces to 1452, 1453, 1454
PGS-1080	1	trace could be strengthened	add trace to 1448
PGS-1090	1	trace could be strengthened	add trace to 1448
PGS-1220	1	trace could be strengthened	add traces to 570, 1093, 1436
PGS-1230	1	trace could be strengthened	add traces to 570, 1093, 1436
PGS-1250	3	No traces specified	add trace to 623
PGS-1310	1	trace could be strengthened	add traces to 1586, 1599
PGS-1400	1	trace could be strengthened	add trace to 1542

Exhibit C-6: SDPS/PGS Level 3 to Level 2 Traceability Issues Summary

L3 Rqmt Id	Severity Rating	Problem Description	Recommendation
DADS0110	1	trace could be strengthened	add trace to 1602
DADS0120	1	trace could be strengthened	add trace to 1447
DADS0140	1	trace could be strengthened	add trace to 1447
DADS0145	1	trace could be strengthened	add trace to 1447
DADS0170	1	trace could be strengthened	add trace to 1447
DADS0175	1	weak trace, trace could be strengthened	delete trace to 1437. add trace to 1447.
DADS0180	1	trace could be strengthened	add trace to 1447
DADS0190	1	trace could be strengthened	add trace to 1447
DADS0260	2	traces are not appropriate	delete traces to 614, 651, 1383. add trace to 1436.
DADS0320	1	trace could be strengthened	add traces to 1345, 1570
DADS0570	1	weak trace	delete trace to 659
DADS0610	1	weak trace	delete trace to 944
DADS0700	3	incorrect traces	delete traces to 570, 614, and 623. add traces to 876, 599, and 1337.
DADS0890	1	trace could be strengthened	add trace to 1597
DADS0901	2	incomplete trace	add traces to 599, 661
DADS1020	1	weak trace	delete trace to 625
DADS1160	1	traces could be strengthened	add trace to 607
DADS1350	1	weak trace	delete trace to 1178
DADS1375	2	trace could be strengthened	add traces to 887, 1493, 1447
DADS1390	1	weak trace	delete trace to 1599
DADS1510	1	trace could be strengthened	add trace to 607
DADS1520	1	trace could be strengthened	add trace to 1447
DADS1550	1	trace could be strengthened	add traces to 1287, 1345
DADS1610	1	weak trace	delete trace to 1275
DADS1640	3	no traces specified	add traces to 623, 662, 1131
DADS1805	1	trace could be strengthened	add traces to 586
DADS1950	3	no traces specified	add trace to 1587
DADS1960	2	incomplete trace	add trace to 1587
DADS2060	2	weak traces, incomplete trace	delete traces to 1158, 1272. add traces to 1235, 1414
DADS2230	1	trace could be strengthened	add traces to 624, 1597
DADS2315	1	weak trace	delete trace to 1116
DADS2440	1	trace could be strengthened	add traces to 625, 876, 1272
DADS2460	1	trace could be strengthened	add trace to 876
DADS2950	1	weak trace	delete trace to 651
DADS3010	1	trace could be strengthened	add traces to 1566, 1567
DADS3040	2	incomplete trace	add trace to 1449
DADS3055	2	incomplete trace	add traces to 873, 877
DADS3090	1	trace could be strengthened	add trace to 1599

Exhibit C-7: SDPS/DADS Level 3 to Level 2 Traceability Issues Summary

L3 Rqmt Id	Severity Rating	Problem Description	Recommendation
DADS0110	1	trace could be strengthened	add trace to 1602
DADS0120	1	trace could be strengthened	add trace to 1447
DADS0140	1	trace could be strengthened	add trace to 1447
DADS0145	1	trace could be strengthened	add trace to 1447
DADS0170	1	trace could be strengthened	add trace to 1447

DADS0175	1	weak trace, trace could be strengthened	delete trace to 1437. add trace to 1447.
DADS0180	1	trace could be strengthened	add trace to 1447
DADS0190	1	trace could be strengthened	add trace to 1447
DADS0260	2	traces are not appropriate	delete traces to 614, 651, 1383. add trace to 1436.
DADS0320	1	trace could be strengthened	add traces to 1345, 1570
DADS0570	1	weak trace	delete trace to 659
DADS0610	1	weak trace	delete trace to 944
DADS0700	3	incorrect traces	delete traces to 570, 614, and 623. add traces to 876, 599, and 1337.
DADS0890	1	trace could be strengthened	add trace to 1597
DADS0901	2	incomplete trace	add traces to 599, 661
DADS1020	1	weak trace	delete trace to 625
DADS1160	1	traces could be strengthened	add trace to 607
DADS1350	1	weak trace	delete trace to 1178
DADS1375	2	trace could be strengthened	add traces to 887, 1493, 1447
DADS1390	1	weak trace	delete trace to 1599
DADS1510	1	trace could be strengthened	add trace to 607
DADS1520	1	trace could be strengthened	add trace to 1447
DADS1550	1	trace could be strengthened	add traces to 1287, 1345
DADS1610	1	weak trace	delete trace to 1275
DADS1640	3	no traces specified	add traces to 623, 662, 1131
DADS1805	1	trace could be strengthened	add traces to 586
DADS1950	3	no traces specified	add trace to 1587
DADS1960	2	incomplete trace	add trace to 1587
DADS2060	2	weak traces, incomplete trace	delete traces to 1158, 1272. add traces to 1235, 1414
DADS2230	1	trace could be strengthened	add traces to 624, 1597
DADS2315	1	weak trace	delete trace to 1116
DADS2440	1	trace could be strengthened	add traces to 625, 876, 1272
DADS2460	1	trace could be strengthened	add trace to 876
DADS2950	1	weak trace	delete trace to 651
DADS3010	1	trace could be strengthened	add traces to 1566, 1567
DADS3040	2	incomplete trace	add trace to 1449
DADS3055	2	incomplete trace	add traces to 873, 877
DADS3090	1	trace could be strengthened	add trace to 1599

Exhibit C-7: SDPS/DADS Level 3 to Level 2 Traceability Issues Summary

L3 Rqmt Id	Severity Rating	Problem Description	Recommendation
IMS-0050	1	weak trace	delete traces to 1116, 1236
IMS-0060	1	weak trace	delete trace to 1236
IMS-0070	1	weak trace	delete trace to 1236
IMS-0090	1	weak traces	delete traces to 1116, 1236
IMS-0110	1	trace could be strengthened	add trace to 651
IMS-0160	1	weak traces	delete traces to 1116, 1236
IMS-0190	1	trace not applicable	delete trace to 1122
IMS-0220	3	no traces specified	add trace to 659
IMS-0250	2	weak trace, incomplete trace	delete trace to 586, add trace to 1566
IMS-0260	3	incorrect traces	review existing traces for deletion. add traces to 1393, 1397
IMS-0300	2	traces are not appropriate	delete traces to 607, 586, 1287
IMS-0460	2	incomplete trace	add trace to 892
IMS-0500	1	weak traces	delete traces to 1116, 1236

IMS-0560	1	weak trace	delete trace to 1236
IMS-0575	1	trace could be strengthened	add trace to 651
IMS-0630	1	weak trace	delete trace to 1236
IMS-0650	1	weak trace	delete trace to 1236
IMS-0660	1	weak traces	delete traces to 1116, 1236
IMS-0680	1	weak trace, trace could be strengthened	delete trace to 1236. add trace to 1344
IMS-0700	1	weak trace	delete trace to 954
IMS-0705	3	no traces specified	add traces to 651, 656, 1399
IMS-0720	1	weak traces	delete traces to 954, 1236
IMS-0740	3	incorrect traces	delete trace to 954. add traces to 625, 651,1569.
IMS-0770	1	weak trace	delete traces to 1236
IMS-0780	1	weak traces	delete traces to 954, 1236
IMS-0790	1	weak trace	delete trace to 1236
IMS-0800	1	trace not applicable, trace could be strengthened	delete trace to 954. add trace to 651
IMS-0950	1	weak trace	delete trace to 1236
IMS-0970	3	no traces specified	Add traces 586, 1286
IMS-0980	1	weak traces	delete traces to 583, 636, 1156, 1272
IMS-0990	1	trace could be strengthened	add trace to 635
IMS-1080	1	weak trace	delete trace to 1236
IMS-1090	1	weak traces	delete traces to 954, 1236
IMS-1210	1	trace could be strengthened	add traces to 1153 and 1445
IMS-1220	2	incomplete trace	add trace to 625
IMS-1430	3	no traces specified	add trace to 1345

Exhibit C-8: SDPS/IMS Level 3 to Level 2 Traceability Issues Summary

L3 Rqmt Id	Severity Rating	Problem Description	Recommendation
SMC-1330	2	incomplete trace	add trace to 885
SMC-1350	1	trace could be strengthened	add trace to 1156
SMC-2100	1	weak traces	delete traces to 892, 944, 1116, 1154, 1158, 1236, 1272, 1324, 1339, 1456
SMC-2200	3	no traces specified	add traces to 1542 and 1589
SMC-2210	3	no traces specified	add traces to 1542, 1587 and 1589
SMC-2220	1	trace could be strengthened	add trace to 1593
SMC-2410	1	trace could be strengthened	add traces to 1120, 1122
SMC-2420	2	incomplete trace	add traces to 1120, 1122
SMC-2500	1	trace could be strengthened	add traces to 1345, 1595
SMC-2510	2	weak trace, incomplete trace	delete trace to 1464. add trace to 1542
SMC-2600	2	incomplete trace	add traces to 1464, 1122, 1257, 1542, 1595
SMC-3300	1	trace could be strengthened	add traces to 1547, 1594
SMC-3370	1	trace could be strengthened	add traces to 1243, 1261
SMC-3380	1	trace could be strengthened	add traces to 1261
SMC-4300	2	incomplete trace	add trace to 1589
SMC-4310	1	trace could be strengthened	add trace to 1589
SMC-4311	1	trace could be strengthened	add trace to 1589
SMC-4330	1	trace could be strengthened	add trace to 1589
SMC-5360	1	trace could be strengthened	add trace to 1588
SMC-6300	1	weak trace	delete traces to 1322
SMC-6301	1	weak trace	delete traces to 1322
SMC-6340	2	weak trace, incomplete trace	delete trace to 1403. add trace to 1593

SMC-6360	1	trace could be strengthened	add traces to 1590, 1597
SMC-6380	1	trace could be strengthened	add trace to 1597
SMC-6400	1	trace could be strengthened	add trace to 1590
SMC-6410	1	trace could be strengthened	add trace to 1590
SMC-6420	1	trace could be strengthened	add trace to 1590
SMC-7300	1	weak trace	delete traces to 624
SMC-8300	1	weak trace, trace could be strengthened	delete traces to 649, 873, 944, 1092, 1158, 1456. add trace to 1591.
SMC-8700	1	trace could be strengthened	add traces to 658, 1591
SMC-8710	1	trace could be strengthened	add trace to 1591
SMC-8730	3	no traces specified	add traces to 1593, 1587
SMC-8750	3	no traces specified	add traces to 1591, 1587, 1122
SMC-8770	3	no traces specified	add traces to 1597, 1542
SMC-8790	1	trace could be strengthened	add traces to 1591, 1542
SMC-8800	1	trace could be strengthened	add traces to 1545, 1594
SMC-8820	1	trace could be strengthened	add trace to 1594
SMC-8840	1	trace could be strengthened	add traces to 1593, 1595, and 1597
SMC-8841	1	trace could be strengthened	add trace to 1596
SMC-8860	1	trace could be strengthened	add trace to 1589
SMC-8880	1	trace could be strengthened	add traces to 1591, 1588
SMC-8890	1	trace could be strengthened	add traces to 1591, 1590, 1595, 1596
SMC-8920	1	trace could be strengthened	add traces to 624, 1590

Exhibit C-9: CSMS/SMC Level 3 to Level 2 Traceability Issues Summary

L3 Rqmt Id	Severity Rating	Problem Description	Recommendation
SMC-1305	1	weak trace	delete trace to 583
SMC-1315	1	weak trace	delete trace to 583
SMC-2105	1	weak traces	delete traces to 892, 944, 1116, 1154, 1158, 1236, 1272, 1324, 1339, 1456
SMC-2205	3	no traces specified	add traces to 1020, 1249
SMC-2215	3	no traces specified	add traces to 1020, 1249
SMC-2405	1	trace could be strengthened	add traces to 1120, 1122, 1257
SMC-2415	1	trace could be strengthened	add traces to 1120, 1122
SMC-2505	1	trace could be strengthened	add traces to 1345, 1595
SMC-2605	2	incomplete trace	add traces to 1464, 1122, 1257, 1282, 1542, 1595
SMC-3305	1	trace could be strengthened	add traces to 1547, 1594
SMC-3345	1	trace could be strengthened	add traces to 1187, 1328
SMC-3385	1	weak trace	delete trace to 1346
SMC-4315	1	trace could be strengthened	add trace to 1419
SMC-4325	1	trace could be strengthened	add trace to 1419
SMC-4335	1	trace could be strengthened	add trace to 1419
SMC-6345	2	incomplete trace	add traces to 1590, 1593, 1595
SMC-6385	1	trace could be strengthened	add trace to 1597
SMC-8305	1	trace could be strengthened	add trace to 1591
SMC-8705	1	trace could be strengthened	add trace to 658
SMC-0300	1	trace could be strengthened	add traces to 1131, 1599
SMC-0310	1	trace could be strengthened	add trace to 1131
SMC-0320	1	trace could be strengthened	add traces to 1187, 1272, 1445
SMC-0330	1	trace could be strengthened	add traces to 1187, 1272

SMC-0340	1	trace could be strengthened	add traces to 1187, 1346
SMC-0350	1	trace could be strengthened	add traces to 1252, 1257, 1455, 1588

Exhibit C-9: CSMS/SMC Level 3 to Level 2 Traceability Issues Summary

L3 Rqmt Id	Severity Rating	Problem Description	Recommendation
ESN-0005	3	incorrect trace	delete traces to 649, 885, 1092, 1152, 1174, 1252. add trace to 1450
ESN-0006	1	trace could be strengthened	add traces to 1540
ESN-0010	2	incomplete trace	add traces to 1172, 1174, and 1605 (Vol. 1), and 3305, 3307 (Vol. 0)
ESN-0240	1	weak trace, trace could be strengthened	delete trace to 1247. add trace to 3298 (volume 0)
ESN-0250	1	trace could be strengthened	add trace to 651
ESN-0280	1	trace could be strengthened	add traces to 3305, 3307 (volume 0)
ESN-0350	3	no traces specified	add traces to 1133, 1605
ESN-0600	1	weak traces	delete traces to 1152, 1153
ESN-0610	1	weak trace	delete trace to 1178
ESN-0740	1	weak trace	delete trace to 1173
ESN-0810	1	trace could be strengthened	add traces to 1346, 1589
ESN-0910	1	trace could be strengthened	add traces to 1346, 1589
ESN-1206	1	weak traces	delete traces to 885, 1131, 1177
ESN-1207	1	weak trace	delete trace to 1247

Exhibit C-10: CSMS/ESN Level 3 to Level 2 Traceability Issues Summary

L2 Rqmt Id	Severity Rating	Problem Description	Recommendation
Section 3.1.1 Overall System			
1242	3	no traces to L1 specified	add trace; potential candidates are: 4.2.3, 8.2.2.1a2, 8.2.3.3a, 8.2.3.3a1, 8.2.3.3a2, 8.2.3.3a3
1235	3	no traces to L1 specified	add trace; potential candidates are: 8.2.1a, 8.2.1f, 8.2.3.3a
1539	1	trace to L1 could be strengthened	add trace to 4.2.7 [565]
1017	1	trace to L3 could be strengthened	add traces to EOSD0540, EOSD0545, EOSD0520
1018	1	trace to L3 could be strengthened	add trace to EOSD0520
1131	3	no traces to L1 specified	add trace; potential candidate is: 11.9 [315]
870	3	no traces to L1 specified	add trace; potential candidates are: 8.2.2.8b1, 8.2.2.8b2
1016	1	traces to L1 and L3 could be strengthened	add trace to L1 8.2.2.1d, add trace to one or more of L3: EOSD2400, EOSD3500, EOSD3510, EOSD3600, EOSD3615
1162	1	trace to L1 could be strengthened	add trace to 8.2.1a and/or 8.2.2.7a1
576	3	no traces to L1 specified	add trace; potential candidates are: 8.2.2.2a, 8.2.3.3a1
509	1	trace to L3 could be strengthened	add trace to EOSD0500
1386	1	trace to L1 could be strengthened	add trace to 11.9 [317]
1282	1	weak traces to L1	delete traces to 11.6.2 [652, 653, 654, 355]
1248	1	trace to L3 could be strengthened	add trace to EOSD1170
1607	1	trace to L1 could be strengthened	add trace to 8.2.2.1d
1579	3	no traces to L3 specified	add trace; potential candidates are: EOSD0500, EOSD1010, FOS-0040
1577	3	no traces to L3 specified	add trace; potential candidates are: ESN-0010, ESN-0240, EOSD5060, EOSD5110, EOSD5250
1264	2	functionality specified in L1 trace potentially omitted at L2	examine linked L1 requirement 4.2.8; consider modifying L2 requirement to ensure functionality is not lost
1322	1	weak traces to L1	delete traces to 8.2.2.4c, 8.2.2.7a2. add trace to 11.9 [314]
1262	1	trace to L1 could be strengthened	add trace to 11.9 [314]
1263	1	trace to L1 could be strengthened	add trace to 11.9 [314]
1115	1	weak trace to L3	delete trace to DADS0210, add a stronger DADS trace
1116	1	weak traces to L3	consider deleting traces to several DADS, IMS and SMC rqmts

954	1	weak traces to L3	consider deleting traces to IMS-0790, IMS-0810, IMS-0820, IMS-0970, and IMS-0990
1122	1	weak trace to L3	delete trace to IMS0190
1392	1	trace to L1 could be strengthened	add trace to 11.2 [290]
1603	1	weak trace to L1	delete trace to 8.2.2.4c, add trace to 8.2.4.3
1423	1	trace to L3 could be strengthened	add trace to IMS-0030
1252	1	weak trace to L3, trace to L3 could be strengthened	delete trace to IMS-1640, add traces to appropriate FOS rqmts
1254	1	weak trace to L3	delete trace to EOSD1502
1257	2	incomplete trace to L1	add trace to 13.2
1455	3	no traces to L1 specified, weak traces to L3	add trace to L1; potential candidates are: 8.2.2.4a, 13.2. delete L3 traces to SMC-5350, SMC5365
1187	1	weak traces to L3	delete traces to SMC-1305, SMC-3415, DADS2110
906	1	trace to L3 could be strengthened	add traces to FOS rqmts; candidates are EOC-8230, ICC-4520
873	3	no traces to L1 specified, weak links to L3	add trace to L1, potential candidates are: 11.9 [314], 12.2. delete traces to L3 DADS3010, SMC-8300. Add L3 links to EOC-4168, ICC-3270, ICC-3280
1088	3	no traces to L1 specified	add trace; potential candidate is: 11.9 [314]
872	1	weak trace to L3	delete trace to IMS-1385

Exhibit C-11: Level 2 Volume 1 Requirements Traceability Issues Summary

L2 Rqmt Id	Severity Rating	Problem Description	Recommendation
1346	1	traces to L1 and L3 could be strengthened	add trace to L1 11.9 [314]. add trace to L3 EOSD5110, EOC-6195, ICC-4150, ICC-4590
Section 3.1.2 ECS Functions			
1324	3	no traces to L1 specified	add trace; potential candidates are: 8.2.2.8a1, 8.2.2.7a, 8.2.2.7a3
1402	3	no traces to L1 specified	add trace; potential candidates are: 8.2.2.8a, 8.2.4.3
596	2	traces to deleted L3 rqmts	delete traces to ICC-1041, ICC-1042, ICC-1044, ICC-1050, ICC-1060, ICC-1070, ICC-1082, IC-1110, ICC-1140, ICC-1150, ICC-1160, ICC-7190, ICC-7200
1410	2	traces to deleted L3 rqmts	delete traces to ICC-1140, ICC-1150
1325	2	traces to deleted L3 rqmts	delete traces to ICC-1010, ICC-1170
1099	2	traces to deleted L3 rqmt	delete trace to ICC-1115
632	1	2 rqmts with same id in trace report, rqmt not in spec	assign different requirement ids or delete one requirement; add requirement to L2 requirements spec
1551	2	traces to deleted L3 rqmt	delete trace to ICC-1060
1269	2	traces to deleted L3 rqmt	delete trace to ICC-1115
1552	3	no traces to L1 specified	add trace; potential candidate is: 8.3.10.6
1369	3	2 rqmts in spec with same id	correct the L2 requirements spec
1413	1	weak traces to L3	consider deleting traces to SMC-1500, SMC-3310, SMC-3320, SMC-3330
1414	2	traces to deleted L3 rqmt	delete trace to ICC-4412
1273	3	no traces to L1 specified	add trace; potential candidate is: 8.2.2.2a
1416	2	traces to deleted L3 rqmts	delete traces to ICC-1090, ICC-1100, ICC-7110, ICC-7150, ICC-7180, ICC-7190, ICC7200, ICC-7530
1417	1	weak trace to L3	consider deleting trace to EOC-6210
1555	3	no traces to L1 specified	suitable trace not found
1419	2	incomplete trace to L3	add traces to SMC-4315, SMC-4325, SMC-4335
1429	3	no traces to L1 specified	add trace; potential candidate is: 8.2.2b
1492	3	no traces to L1 specified	add trace; potential candidates are: 8.2.2.2a, 8.2.3.3a1
614	3	no traces to L1 specified	add trace; potential candidates are: 8.2.2.1a1, 8.2.2.1a3
661	2	all traces are weak	delete current traces, consider adding trace to 8.2.2.4a
1337	3	no traces to L1 specified	add trace; potential candidates are: 8.2.1a, 4.2.4
1437	3	no traces to L1 specified	add trace; potential candidate is: 4.2.6
1602	3	no traces to L1 specified	add trace; potential candidate is: 11.9

1092	3	no traces to L1 specified	add trace; potential candidates are: 8.2.2.3c, 8.2.2.7a1
649	1	trace to L1 could be strengthened	add trace to 8.2.2.3c
885	3	no traces to L1 specified	add trace; potential candidates are: 8.2.2.3c, 8.2.2.7a1
1152	3	no traces to L1 specified	add trace; potential candidates are: 8.2.2.3c, 8.2.2.7a1
635	1	trace to L1 could be strengthened	add traces to 8.2.2.4a, 8.5.2.5
1565	1	trace to L1 could be strengthened	add trace to 8.2.1c
949	3	no traces to L1 specified	add trace; potential candidate is: 8.2.2.5
892	1	trace to L1 could be strengthened	add trace to 8.2.1c
583	1	trace to L1 could be strengthened	add trace to 8.2.2.3c
1440	3	incorrect trace to L1	delete trace to 8.8.8.8a, add traces to 11.6.2 [653, 654]
1441	3	no traces to L1 specified	add trace; potential candidates are: 8.2.1c, 8.2.2.6a
1585	3	no traces to L1 specified	add trace; potential candidate is: 8.2.2.7a
894	1	trace to L1 could be strengthened	add trace to Appendix C, Data Information Policy

Exhibit C-11: Level 2 Volume 1 Requirements Traceability Issues Summary

L2 Rqmt Id	Severity Rating	Problem Description	Recommendation
1160	3	no traces to L1 specified	add trace; potential candidates are: 8.2.2.1a1, 8.2.2.1a2
580	3	no traces to L1 specified	add trace; potential candidates are: 8.2.2.1a1, 8.2.2.1a2
607	3	no traces to L1 specified	add trace; potential candidates are: 8.2.2.5, 8.2.2.7a3
1448	3	no traces to L1 specified	add trace; potential candidate is: 8.2.1c
1493	2	weak traces to L1	add trace to 8.2.2.3d
1442	3	no traces to L1 specified	add trace; potential candidate is: 8.2.2.5
625	3	no traces to L1 specified	add trace; potential candidates are: 8.2.1c, 8.2.2.1a, 8.2.2.6
599	1	trace to L1 could be strengthened	add trace to 8.2.2.1
1569	3	no traces to L1 specified	add trace; potential candidate is: 8.2.1c
1275	3	no traces to L1 specified	add trace; potential candidates are: 4.2.8, 8.2.2.7a2, 11.6.1 [299], 11.9 [314], 13.2
1172	3	no traces to L1 specified	add trace; potential candidates are: 8.2.2.7a2, 8.2.3.3a
1173	3	no traces to L1 specified	add trace; potential candidate is: 8.2.3.3a
1342	2	weak trace to L1	delete trace to 8.2.2.7a2, consider adding traces to 4.2.8, 11.6.1 [299]
1177	3	no traces to L1 specified	add trace; potential candidates are: 8.2.2.8a, 8.2.3.3a
1178	1	trace to L1 could be strengthened	add trace to 8.2.2.7c
1175	1	trace to L1 could be strengthened	add trace to 11.6.2 [654]
1180	1	weak traces to L1and L3	delete L1 trace to 8.2.2.4c, delete trace to L3 ESN-0815
1176	3	no traces to L1 specified	add trace; potential candidates are: 11.6.2 [652, 654], 11.9 [314]
876	1	trace to L1 could be strengthened	add trace to 8.2.2.1
1165	3	no traces to L1 specified, weak link to L3	add trace to L1; potential candidate is:8.2.2.4a, delete links to L3: DADS0570, ESN-0450
659	3	no traces to L1 specified, weak link to L3	add trace to L1-suitable candidate not found, delete links to L3: DADS0570
624	3	no traces to L1 specified	add trace; potential candidate is: 8.2.2.1a1
1451	3	no traces to L1 specified	add trace; potential candidate is: 8.2.2.4a
1453	3	no traces to L1 specified	add trace; potential candidate is: 8.2.4.4
1604	3	no traces to L1 specified	add trace; potential candidate is: 8.2.4.4
1542	3	no traces to L1 specified	add trace; potential candidates are: 8.2.2.1a1, 8.2.2.5
1545	1	trace to L3 could be strengthened	add traces to EOC-8230, ICC-6080
1588	1	trace to L3 could be strengthened	add traces to EOC-8270, ICC-6200
1589	3	no traces to L1 specified, links to L3 could be strengthened	add trace to L1; potential candidates are:11.6.2 [652, 654], 11.9 [314. add links to L3: EOC-8220, ICC-6110
1590	1	trace to L3 could be strengthened	add traces to EOC-8230, EOC-8370, ICC-6120
1591	1	trace to L1 could be strengthened	add trace to 8.2.2.7a2, 8.2.2.4a
1592	3	no traces to L1 specified	add trace; potential candidates are: 8.2.3.3a, 8.2.3.3a1

1596	1	trace to L1 could be strengthened	add trace to 13.2
891	1	trace to L1 could be strengthened	add trace to 4.2.8
Section 3.2 ECS Evolutionary Approach Concepts			
1457	3	no traces to L1 specified	add trace; potential candidates are: 4.2.8, 8.2.2.8b1
1461	2	incomplete trace to L3	suitable trace not found
1462	1	trace to L3 could be strengthened	add trace to EOSD5020
1463	3	no traces to L1 specified	suitable trace not found
1464	1	weak trace to L3	delete trace to DADS0260

Exhibit C-11: Level 2 Volume 1 Requirements Traceability Issues Summary

L2 Rqmt Id	Severity Rating	Problem Description	Recommendation
1465	1	weak trace to L1	delete trace to 9.2.2, consider adding traces to 8.2.2.8a and/or 4.2.8
1468	3	no traces to L1 specified	suitable trace not found
1574	3	no traces to L1 specified, weak trace to L3	suitable trace to L1 not found, delete link to L3 ESN1350

Exhibit C-11: Level 2 Volume 1 Requirements Traceability Issues Summary

APPENDIX D: INDIVIDUAL REQUIREMENT ANALYSIS DETAIL

This Appendix contains the detailed technical integrity assessment for ECS Level 3 traceability, quality, and testability analyses, and ECS Level 2 (Volume 1) traceability analyses. There is one technical integrity form for each requirement having any type of issue; the form describes all issues for the requirement. Appendix C contains a summary of all traceability issues identified across ECS levels 1, 2, and 3.

THIS APPENDIX PUBLISHED SEPARATELY

APPENDIX E: TOOLS AND DATABASES UTILIZED

Tools and databases utilized in the evaluation of the ECS requirements are the same as those used in the preliminary requirements analysis, and are listed in Exhibit G-1.

IV&V Tools	Environment	Purpose
ARDB, implemented using: Excel 5.0 Word 6.0	**PC**	**Repository for the requirements analysis results. Requirements databases are Excel files containing analysis rationale as embedded Word documents.**
Novell Netware LAN WorkPlace	**PC**	**Information transfer and sharing. Enables transfer of files from the Sun to the PCs. Facilitates import of RTM files.**
RTM	**Sun**	**Source of ECS Level 2 to Level 1 traceability information. IV&V receives snapshots (via RTM import) RTM database for analysis purposes.**

EXHIBIT E-1: Tools and Databases Used

The Automated Requirements Analysis Database (ARDB) is the repository for the requirements analysis and traceability findings. Results are stored in Excel spreadsheets files under a hierarchy of subdirectories. The spreadsheets contain analysis metrics and links to electronic Technical Integrity Evaluation Forms. Exhibit G-2 shows the established directory structure used for this analysis.

Subdirectory	Contents
L2Vol1	**ESDIS Level 2 Volume 1 (ECS) requirements databases containing results of Level 2 to Level 1 and Level 2 to Level 3 traceability analyses**
EOSD	**ECS EOSD (system-level) Level 3 requirements analysis databases**
SDPS	**ECS SDPS (segment-level) Level 3 requirements analysis databases**
PGS	**ECS PGS Level 3 requirements analysis databases**
DADS	**ECS DADS Level 3 requirements analysis databases**
IMS	**ECS IMS Level 3 requirements analysis databases**
FOS	**ECS FOS (segment-level) Level 3 requirements analysis databases**
EOC	**ECS EOC Level 3 requirements analysis databases**
ICC	**ECS ICC Level 3 requirements analysis databases**
SMC	**ECS SMC Level 3 requirements analysis databases**
ESN	**ECS ESN Level 3 requirements analysis databases**

EXHIBIT E-2: IV&V Requirements Analysis Databases Partitioning Schema

APPENDIX F: LIST OF REFERENCES

1. *EOSDIS Core System (ECS) Preliminary Requirements Analysis Report,* Intermetrics, EOSDIS IV&V Deliverable #0502, October 28, 1994.

2. *EOSDIS IV&V Independent System Verification Plan (ISVVP),* Intermetrics, October 17, 1994.

3. *Functional and Performance Requirements Specification for the Earth Observing System Data and Information System (EOSDIS) Core System,* Revision A, 423-41-02, June 2, 1994, through CH-07 (February 15, 1995).

4. *Earth Science Data and Information System (ESDIS) Project Level 2 Requirements, EOSDIS Core System (ECS), Volume 1,* Revision A, 423-10-01-1, January 27, 1993, through CH-21 (February 15, 1995).

5. *Earth Science Data and Information System (ESDIS) Project Level 2 Requirements, EOSDIS Core System (ECS), Volume 0,* 423-10-01-0, February 18, 1993, through CH-04 (November 10, 1994).

6. *Execution Phase Project Plan for the Earth Observing System* (EOS, Revision A, GSFC 170-01-01, May 1995.

7. *Earth Observing System (EOS) Level 1 Requirements Document*, GSFC, March 31, 1995.

8. CCR 01-41-075 Impact Analysis Report, *Reduce Quick-look to Expedited Data*, 4/17/95

9. Level 3 to Level 2 Requirements Trace Report, Provided by CSC for NASA GSFC Code 500, June 20, 1994.

10. Level 2 to Level 3 Requirements Trace Report, Provided by CSC for NASA GSFC Code 500, June 20, 1994.

11. Level 2 to Level 1 Requirements Trace RTM Data, Provided by CSC for NASA GSFC Code 170, May 31, 1995. Updated report received on June 28, 1995.